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PARKS

AN INTERNATIONAL JOURNAL FOR MANAGERS OF NATIONAL PARKS, HISTORIC SITES, AND OTHER PROTECTED AREAS

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Volume 2 Number 4 January, February, March 1978

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Cover: Perforated stone stupas containing statues of Buddha grace the ancient Temple of Borobudur in Central Java. The stupa which originally protected the statue in the foreground has not been reconstructed. Photo: UNESCO/David Davies. Back cover: Bicycle path through climax beech and red maple forest on stable dunes, Cape Cod National Seashore. Photo: Paul J. Godfrey.

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W. Brown Morton III

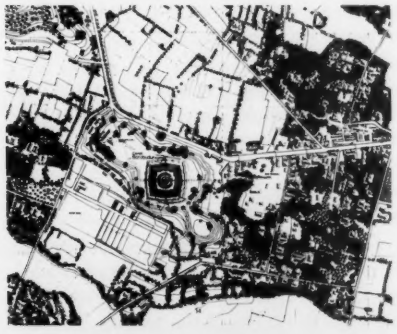
The Preservation of Borobudur, Indonesia

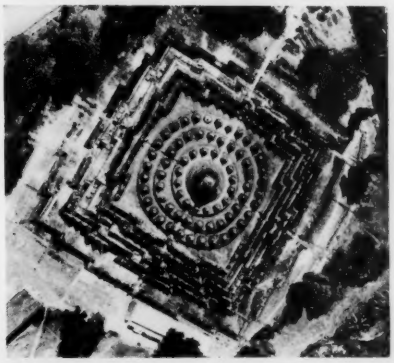
There is a folk tradition in Indonesia that the island of Java had to be nailed in place to fix its location in the ocean and that the head of the nail is the hill in south central Java known today as Tidar. The countryside around "The nail of Java" is renowned for its lush beauty, its fertility, and for its four volcanoes. One of these volcanoes, the Merapi, rises to a height of 2911 meters and is still active. Fifteen kilometers south of Tidar hill in a dramatic setting of jagged mountains, rice paddies, and forest is located the extraordinary stone pyramid known as Candi Borobudur, built in the 9th century A.D. (Figure 1).

In 1971, the Government of Indonesia and the United Nations Educational, Scientific and Cultural Organization (UNESCO) began an ambitious U.S. 7.75 million dollar preservation program to stabilize and preserve Borobudur. The program is now well under way and the technical methods being developed and used here deserve our notice and careful study.

In Indonesia, the word Candi refers to an ancient religious monument but does not necessarily designate a temple. The origin of the word Borobudur itself is obscure. There is general agreement, however, that the monument was constructed beginning in the mid-9th century and formed the central feature of a Buddhist monastery complex. Borobudur is essentially a stepped dry stone pyramid built on the rise of a low hill. The structure is composed of nine stone terraces rising to a bell shaped stupa at the top (Figure 2). The first six terraces are square in plan. The balustrades and walls of the square terraces are covered with 1460 panels of exquisite bas-relief sculpture representing scenes from sacred Buddhist texts. The topmost three terraces are circular in plan. The first terrace is 123 meters square at the base and the monument rises to a height of 35 meters above grade. Borobudur is built of dressed grey-brown volcanic stone constructed around a core of earth fill. It is laid up without mortar in an intricate interlocking pattern to permit slight movement without danger of collapse in the case of seismic activity or minor settlement. Borobudur is oriented on a north-south, east-west axis and access to the top is provided by steep stairs in the center of each face. These four stairs also provide access to the nine terraces. The monument has no interior space and therefore is not, strictly speaking, a place of worship; it functions as a Buddhist holy place of pilgrimage and symbolizes through its form and plan the Buddhist concept of the organization of the cosmos and the path man must take through it to achieve union with God. (Figure 3).

In the 9th century, the builders of Borobudur conceived of it as a





Left, Figure 1. Borobudur: Site plan of Candi Borobudur showing village to the east and project working area to the southwest. (Photo: Japan International Cooperation Agency) Below, Figure 2. Borobudur: General view showing condition in 1969. (Photo: BPCB) Below left, Figure 3. Borobudur: Aerial View showing transition from square to circle. (Photo: BPCB)

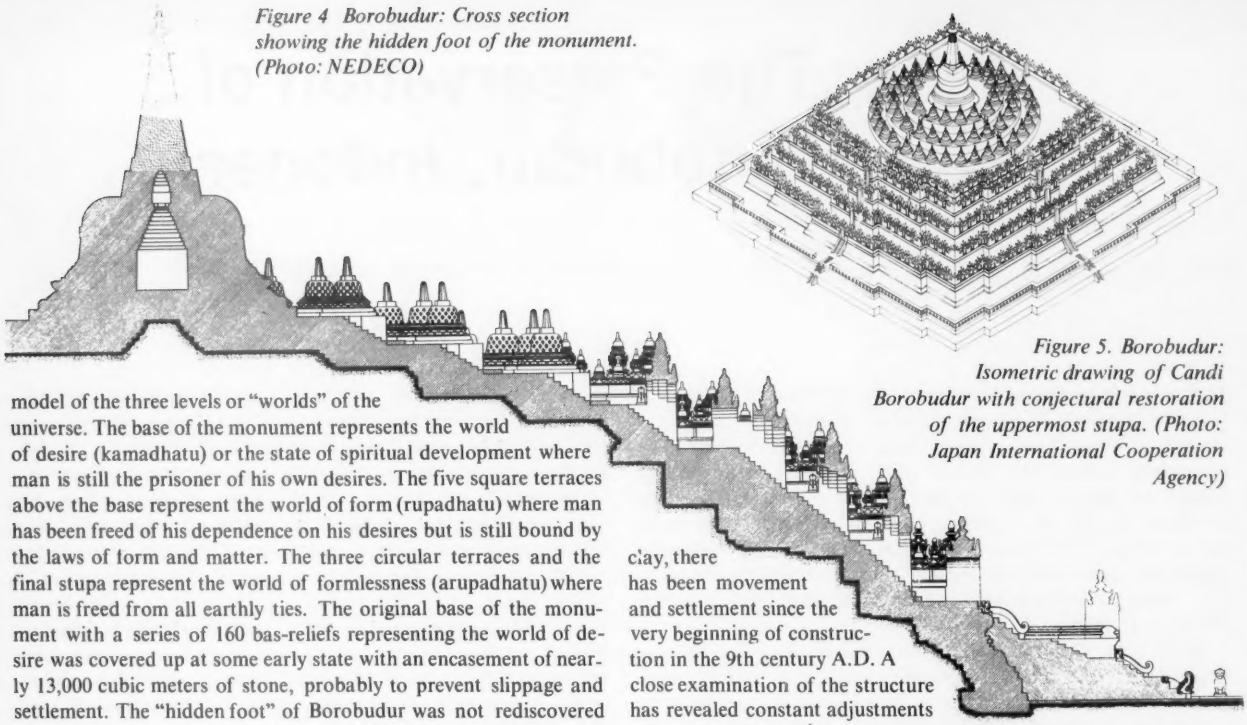


Figure 4 Borobudur: Cross section showing the hidden foot of the monument. (Photo: NEDECO)

Figure 5. Borobudur: Isometric drawing of Candi Borobudur with conjectural restoration of the uppermost stupa. (Photo: Japan International Cooperation Agency)

model of the three levels or "worlds" of the universe. The base of the monument represents the world of desire (kamadhatu) or the state of spiritual development where man is still the prisoner of his own desires. The five square terraces above the base represent the world of form (rupadhatu) where man has been freed of his dependence on his desires but is still bound by the laws of form and matter. The three circular terraces and the final stupa represent the world of formlessness (arupadhatu) where man is freed from all earthly ties. The original base of the monument with a series of 160 bas-reliefs representing the world of desire was covered up at some early state with an encasement of nearly 13,000 cubic meters of stone, probably to prevent slippage and settlement. The "hidden foot" of Borobudur was not rediscovered until 1885. Portions of the original bas-reliefs have now been exposed to view (Figure 4). The square terraces of the world of form have narrow walkways encircling the pyramid. These walkways are flanked by high ornate stone balustrades which carry the sculptured panels and support hundreds of niches, each containing a statue of a seated Buddha. The ornate decoration of these terraces and the visual and physical confinement of the terrace walkways reinforce the symbolism of "rupadhatu" and give Borobudur its essential character when seen from a distance. At the sixth level, the visitor passes through a small cramped archway and emerges out onto the three upper levels of the monument, into the world of formlessness. The actual experience of this transition is as dramatic as a clap of thunder. The plan of the monument changes from square to circular. The elaborate carved panels and niches cease. The upper terraces are virtually free of decoration. The high confining balustrades vanish and one can see out from horizon to horizon in all directions. One is free. Arranged in quiet repose around the upper terraces are three rings of pierced stone stupas each containing a statue of a seated Buddha. The main stupa at the top of the monument is severely plain and carries no decoration at all. Borobudur is the masterpiece of mahayana Buddhism and one of the outstanding examples of objective religious art (Figure 5).

Although the early history of Candi Borobudur is not well recorded, it is probable that the monument fell into disuse in the 15th century when the people of Java were converted to Islam. Borobudur was rediscovered in 1814 during the brief period of British occupation of Java. The Lieutenant Governor-General of Java, Sir Thomas Raffles, had a report of the structure prepared by Cornelius, a Dutch engineer. The first scholarly monograph on Borobudur was published in 1873. When the 'hidden foot' was uncovered in 1885, this discovery sparked wide public interest in Borobudur which in turn led to a decision by the Dutch colonial government to stabilize and restore damaged sections of the structure.

Because Borobudur is built of cut and fitted volcanic stone blocks assembled without mortar around a central core of sandy clay, there has been movement and settlement since the very beginning of construction in the 9th century A.D. A close examination of the structure has revealed constant adjustments and rectification of the stone courses as the building went up.

Over the centuries intermittent seismic activity, water penetration, the uncontrolled growth of vegetation, vandalism, and neglect had taken their toll of this proud "cosmic mountain." Walls had cracked and leaned badly out of plumb. The upper stupa and most of the smaller perforated stupas on the upper terraces had collapsed and many of the statues were missing in whole or in part (Figure 6). The movement of the walls had caused major damage to bas-relief sculptured panels. Uncontrolled water seepage had weakened the clay fill and encouraged deterioration of the surface of the stones, both plain and sculptured.

A Commission was appointed by the Government in 1900 to prepare preservation and consolidation plans. A Dutch army engineer named Van Erp was put in charge of the project. Work commenced in 1907 and was completed in 1911. Under Van Erp, the site immediately surrounding the Candi was excavated, the lower terrace wall was consolidated, extensive repairs were made to the balustrades, stairways, arches, and niches. The major work was the virtual dismantling and reassembling of the fifth terrace balustrade, the three upper circular terraces, and the top stupa. From the time that Van Erp finished his work in 1911 until the beginning of the current project, very little conservation activity other than routine maintenance occurred at Borobudur.

The present project began to take shape in 1955, a few years after the Republic of Indonesia became a member State of UNESCO. At that time the first of a series of UNESCO consultant experts travelled to Borobudur to advise the government's Archeological Institute. The outcome of the consultations was the decision to undertake a massive restoration and stabilization program to rectify the severe structural problems due to continued settlement and water damage and to try to reduce the alarming deterioration of the sculpture and carved decoration (Figures 7 and 8). From 1971 to 1973, the organization of the final project took shape. The government formed the Badan Pemugaran Candi Borobudur (BPCB), the Agency for the Restoration of Candi Borobudur, and also approved a comprehensive preservation project developed by The Nether-

lands Engineering Consultants (NEDECO). UNESCO agreed to organize an international campaign to raise funds for the project and also appointed a UNESCO Coordinator for Monuments and Sites in Indonesia to work as counterpart staff with the BPCB. To monitor the work in progress and modify the work program if necessary, the Government of Indonesia formed a Consultative Committee for the Safeguarding of Borobudur. The members appointed to the Committee were Professor Roosseno, Chairman of the BPCP; Dr. D. Chihara, Japan; Dr. K. Siegler, West Germany; Dr. R. M. Lemaire, Belgium; and Mr. J. E. N. Jensen, United States. In 1975, Mr. Jensen retired from the committee and was replaced by Mr. W. Brown Morton III.

The interim preservation project report, "The Restoration of Borobudur" issued by NEDECO in 1972, identified three principal causes of deterioration:

1. Dramatic acceleration in the rate of deterioration of the bas-relief sculptures, the statues, and the other surface stones caused by physio-chemical and micro-biological attack;
2. Inadequate drainage;
3. Severe settlement cracking and subsidence, especially of the first, second, third, and fourth terraces and balustrades, caused by insufficient bearing capacity of the soil beneath the monument and uncontrolled washing away of the soil fill in the center of the monument.

The NEDECO report called for a series of preservation measures to stabilize Borobudur and to reduce further deterioration to a minimum. These measures included the following:

1. Installation of a drainage system to provide rapid run-off for rainwater.
2. Introduction of waterproof layers to prevent further water infiltration and seepage.
3. Introduction of reinforced concrete slabs under areas of heavy compressive load to distribute the compressive load evenly over a wider area.
4. Cleaning, consolidation, and repair of bas-relief panels, statues, and other stone decoration.

It was decided that the preservation work would include the four square terraces and their balustrades, and the plateau between the fourth square terrace and the first circular terrace, but would not include major work to the ground level encasement surrounding the hidden foot or work on the three circular upper terraces and the final stupa. The Van Erp work at these areas has held up adequately.

The basic preservation scheme is shown in Figure 9. The execution of this work requires the removal, treatment, and eventual replacement of all of the outer stones and many of the inner stones of the areas affected. Over 300,000 outer stones alone will be identified and handled individually in the course of the work. In addition to the reinforced concrete slabs installed to evenly distribute the compressive loads, the scheme calls for the installation of a sophisticated series of waterproof layers. Layer A is a layer of Araldite-tar-epoxy painted over the surface of reset inner stones to prevent seepage between the filled earth core of the monument and the outer stones. Layer B is a vertical layer of treated inner stones covered with Araldite-tar-epoxy set two courses behind the outer decorated stones to prevent moisture moving through the decorated stones by means of capillary action. Layer C is a layer of asphalt on the underside of the new reinforced concrete slabs. There is also a system of hidden drain pipes installed flush with the concrete slabs and beneath the open joints of the relaid terrace floors to carry away rainwater run-off. A filter layer of volcanic sand to aid in drainage is also provided within the wall at each terrace level.

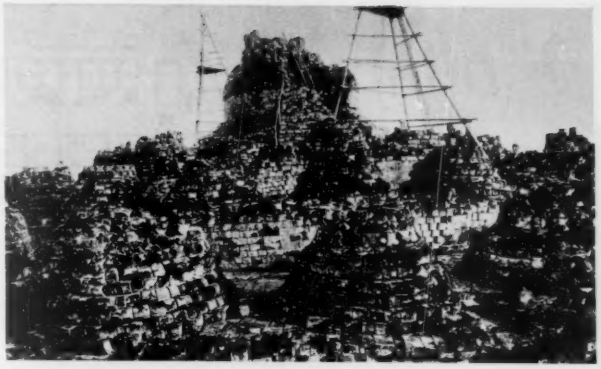


Figure 6. Borobudur: Upper terraces and stupa prior to restoration in 1907. (Photo: BPCB).

In order to achieve the work the following breakdown of tasks was developed by NEDECO:

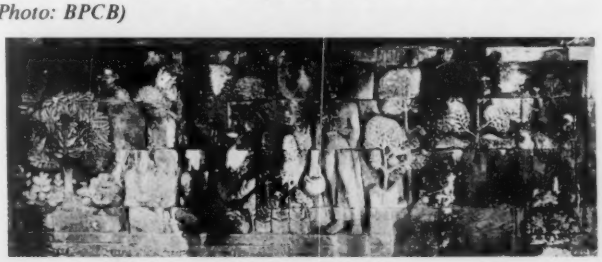
(a) dismantling, transport, and storage of outer stones;
(b) cleaning, repair, and treatment of outer stones;
(c) construction of the reinforced concrete foundation slabs;
(d) transport and treatment of the inner stones;
(e) insertion of the filter layer and waterproof layers;
(f) replacement and reconstruction of the stones of the terraces and balustrades.

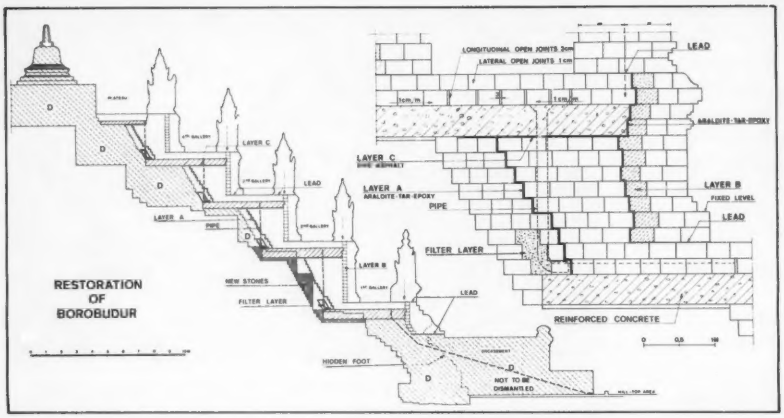
NEDECO also devised an ingenious transportation system to transport the stones from the monument itself to the work area southwest of the hill on which the pyramid is built. The system includes:

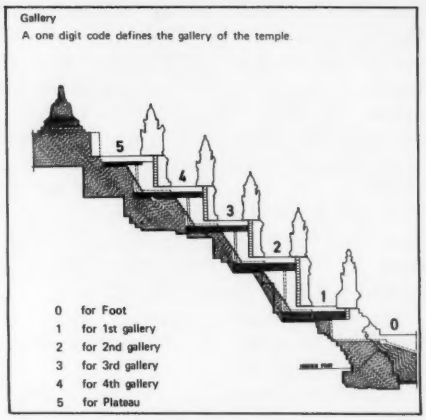
1. A series of small hand-operated cranes at all levels for transport of individual stones from their original location to specially designed wooden pallets.
2. Tower cranes on tracks for vertical transport of the stones in the wooden pallets from the terraces to the ground.
3. Fork lift trucks for transport of pallets to the crane gantry at the southwest side of the hill.
4. A crane gantry for transport of pallets from the hill top to the working area at the foot of the hill.
5. Fork lift trucks for transport of pallets in the working area and to the temporary and final storage areas.

The dismantling of the stones is achieved by working simul-

Left, Figure 7. Borobudur: Bas relief sculptured panel showing condition in 1911. (Photo: BPCB) Right, Figure 8. Borobudur: Bas relief sculptured panel showing deteriorated condition in 1969. (Photo: BPCB)







Left, Figure 9. Borobudur: Cross section showing preservation work to be carried out. (Photo: NEDECO). Right, Figure 10. Borobudur: IBM code numbering system for the galleries. (Photo: BPCB).

taneously on opposite faces of the pyramid so as not to disturb the equilibrium of the monument. The balustrades are taken down first, then the inside terrace walls and floors, and finally the inner stones. Each outer stone is numbered, moved, inspected, cleaned, disinfected, treated, repaired, and stored for eventual replacement on the monument.

In order to achieve this work all stones were recorded by conventional photography and by stereophotogrammetry and then an innovative computer program was devised to number and track the path of each stone through the entire complicated preservation sequence.

The development of this computer program is the single most outstanding technological achievement of the Borobudur project. The program was developed by IBM in cooperation with the Government of Indonesia. A detailed report, "Computerized Stone Registration System for the Restoration Candi Borobudur" by V.K. Khandelwal and M. Soepardi, was published by the Badan Pemugaran Candi Borobudur in 1977.

Some of the problems to be solved by computer were:

(a) numbering and recording of over 400,000 stones;

(b) numbering of pallets;

(c) keeping track of each stone as it moves through the preservation process. Not all stones require the same treatment in the same order, but all stones require some treatment;

(d) organizing temporary storage space before treatment and final storage after treatment but before rebuilding. This is complicated by the fact that dismantling is carried out from the top down and rebuilding is carried out from the bottom up. Also dismantling areas on the monument are not in the same sequence as rebuilding areas;

(e) the number of wooden pallets is limited and they must be efficiently used.

The code used for the stone registration system can be outlined as follows:

A one character code denotes the side of the monument: U= Utara (North), S=Selatan (South), T=Timur (East), and B=Barat (West). A one digit code defines the gallery or terrace level. Each terrace is subdivided into sections: for the main wall sections A to J; for the balustrades A1 to J1 on the inner side, and A2 to J2 on the outer side; for stairways T and for archways Y for the right side and Z for the left side. Then a different number is given for each stone layer of the balustrade and for each stone layer of the main wall. Finally, each wooden pallet is designated by a five digit number based on the side of the monument and the level the stone came from.

Once the numbering and identification of stones and pallets is achieved, various input data are assembled. The input data provided on the input data forms for each pallet of numbered stone, for example, are as follows:

(a) dismantling date
(b) buffer (temporary) storage check-in
(c) buffer storage check-out
(d) treatment order
(e) cleaning
(f) drying
(g) repairing
(h) treatment
(i) final storage check-in
(j) final storage check-out
(k) rebuilding date

The data input is done daily and the data output can be called for at any time. The major benefits of the computer program for Borobudur are:

(a) ensuring the proper and timely treatment of stones;

(b) analysing the efficiency of the overall project operation;

(c) ensuring property coordination between different project phases and identifying and correcting delays;

(d) planning for rebuilding when sufficient stones are ready;

(e) providing adequate project documentation;

(f) checking errors, duplication, and losses.

The development of the computer program for Borobudur has revolutionized large scale preservation project planning and will most certainly have a significant impact throughout the world when other projects of a similar complexity are undertaken.

The first stage of dismantling began simultaneously on the north and south faces of Borobudur on April 24, 1974. The last stage of dismantling was completed on April 21, 1977. The rebuilding of the north and south faces is scheduled to be completed by July 14, 1979. At that time work on the east and west faces will be commenced. By working on only two faces at a time, the overall structural stability of the monument is safeguarded and visitation to the site is at no time interrupted.

When the work is completed in its entirety the Government of Indonesia and UNESCO will have achieved a milestone in historic preservation and made a lasting contribution to the cultural heritage of all mankind.

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Paul J. Godfrey

Management Guidelines for Parks on Barrier Beaches

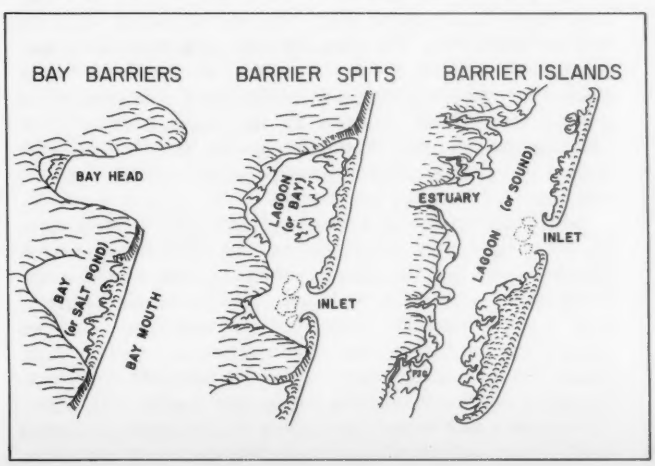
People have long used the seacoast as a source of livelihood and recreation, but only in recent decades have major pressures come to bear on the shoreline. Increasing demands for coastal recreation, as well as the need to protect the remaining undeveloped coastline, have come into direct conflict with development interests. Management approaches to these coastal areas vary considerably around the world, yet certain similarities and lessons can be perceived by looking at the problems faced by the U.S. National Park Service.

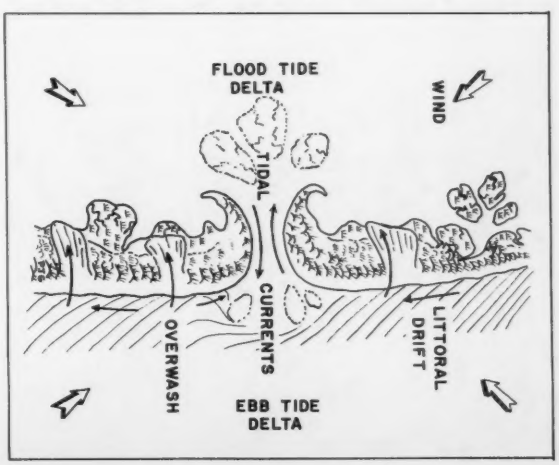
The U.S. NPS now manages 12 park areas along the U.S. east coast, two on the west coast and in Alaska, all of which contain sand beaches and dunes, the main subject of concern in this paper. With such a large section of the coast under its management, most of which came into its charge during the past 15 years, the NPS should have a wide array of management options and experiences from which to draw when it comes to making recommendations to others. While this is true in part, the NPS is still coming to terms with the problems of coastal management and is still looking back at past mistakes which often were made because of lack of information. After years of battling the sea, the NPS is now developing a sounder approach to coastal management. Research and experience gained at various National Seashores, such as Cape Lookout and Cape Hatteras in North Carolina, Fire Island in New York, and others, have provided the background for this change.

What Are Barrier Beaches?

A barrier beach refers to a sandy structure of beaches and dunes which protects a marsh and/or lagoon system from attack by oceanic waves (Figure 1). The key words here are "protect a marsh and/or lagoon" and this function separates the barrier beach from other types of beaches, such as those found at the base of glacial deposits or rocky cliffs. Within this basic form, three sub-types can be identified: bay barrier, spit, and barrier island. Of the three, the spit type barrier beach is most common in the glaciated regions of North America, and other similar coasts, while barrier islands are common south of that region. The best examples of barrier islands in the world can be found along the U.S. east and Gulf coasts from the south shore of Long Island, New York, to Mexico. Barrier spits are attached to a mainland or large island from which the sand that makes up the spit was derived by wave action, and wave-induced sand movement called "littoral drift". The bay barrier is a rather small barrier that forms between two rocky headlands or other land masses extending into the sea. These beaches are often at the head of a fiord, or bay, and usually form as waves move sand up to the head. They often have streams and marshes behind them, and thus fit the criteria of a barrier beach. Such beaches are found along rocky, indented shores. The best example in the NP System is "Sand Beach" in Acadia National Park, Maine.

Left, Figure 1. Types of barrier beaches showing the three basic ways sand, gravel, or other wave-transported sediments are deposited to form barriers which protect a lagoon and/or marsh system from direct ocean wave attack. Bay barriers are connected at each end *to the mainland; barrier spits are attached at* one end *with an inlet at the opposite end, or grow across open water; barrier islands are separated from each other by inlets at* both ends. *Right, Figure 2. Movement of sand along a barrier beach, and through it or over it, is caused by waves (littoral drift), tides (tidal currents), or storm surges (overwash). Wind also moves sand.*





Spit type barriers are rather common features along many coastal areas of the world, with some of the best examples found in the northeastern United States (particularly in Cape Cod National Seashore), the Canadian Maritime Provinces, the British Isles, many parts of the European Coast, Australia, and elsewhere. Barrier spits can grow right across a bay and connect other portions of the mainland, or source of sediment. In some cases, inlets are not regular features, and these barriers show a continuous beach from one sand source to another. Such beaches are referred to as "bay mouth barriers". The lagoons formed behind are often called "salt ponds." Good examples of beaches which connect eroding headlands are found on Martha's Vineyard and Nantucket Island, Massachusetts, and along the Rhode Island shore.

In most cases, however, inlets eventually cause barrier spits to break into separate barrier islands. This frequently happens during major storms, and inlets thus formed may become important features of the environment, although they usually close some time after the storm. Barriers of this type show few differences from the spits of which they are basically a part. The barrier islands along the Long Island shore, New York, which include Fire Island National Seashore; Monomoy Island, Massachusetts; the barriers off the coast of Prince Edward Island, Canada, which includes Prince Edward Island National Park; Holkham Beach, Scolt Head Island and Blakeney Point on the Norfolk Coast of England, and others, appear to be barriers of this category. The general pattern of sand movement is in the same direction as the dominant wave approach, and one can expect such barriers to continue migrating in that direction.

The formation of barrier islands, other than by spits, involves several alternative methods, some of which are not fully understood. Certain barrier islands are clearly sections of a low, gradually sloping coastal plain which have been cut off from the mainland by the rising sea. These islands are made up of typical coastal plain sediments and have a modern beach "welded" onto the front of the island. In general, these islands are relatively high and flat. The dunes present are usually restricted to the seaward portion. Islands of this type often are quite large, and irregularly shaped except for the ocean beach which is smoothed off by wave action. They have been called "sea islands" after the large barrier islands found off the coast of Georgia and South Carolina, USA. Cumberland Island National Seashore is a splendid example of a large sea island.

Stumps of an ancient forest protrude from the shifting sands of a beach in Assateague National Seashore, a barrier island off the coasts of Maryland and Virginia. Photo: M.W. Williams.

Other barrier islands along gradually sloping coastal plains undergoing submergence may have formed initially as sea islands, which are now completely reworked, or by other means. One hypothesis considered by geologists suggests that dune ridges were formed along these mainland shores some 6,000 years ago when the rate of sea level rise slowed. As the sea level continued to rise, these dune ridges were isolated from the mainland, and the low portions behind the dunes were flooded, thus creating the lagoons and bays. As sea level continued to rise, the barriers were pushed back toward the mainland, and regularly broken by inlets. Many islands along the central gulf coast of the U.S. seem to have formed in this manner. Good examples are found in Cape Lookout, Cape Hatteras, and Assateague Island National Seashores.

Natural Forces

The barrier beaches we see today, regardless of how they formed initially, are the products of a complex array of physical forces that develop between the land and the sea. Some of these forces have already been mentioned and they include: sea level change, waves, storm surges and floods, and wind (Figure 2).

Waves play a continuous role in the movement of sand in water. The waves create currents along the shore which move sand in the general direction of the wave approach. The greater the wave energy and angle of wave approach at breaking, the greater is the sand movement. The process is continuous, and as long as waves break on the beach, the sand will move downdrift. Even as waves can move sand up and down a beach, they move the sand on and off. During periods of heavy wave attack, such as in storms or during the winter months, sand is carried offshore into deeper waters to form bars. After the storms, or in summer, the sand is moved back up onto the beach. This cycle of onshore and offshore transport results in beaches which are wide during summer, or quiet non-storm times, and narrow during winter or stormy periods.

Waves can also move sand into inlets where other forces add to their effect. Inlets serve as a means by which sand moves under water to the regions behind a barrier beach. As the tide floods into the inlet, and waves move sand along the beach, shoals are created on the inside of the inlet—the "flood tide delta." When the tide ebbs, currents carry sand from the inner shoals back out into the sea where an ebb tide delta forms. Sand can thus move down the beach, into an inlet, out of the inlet, along the ebb tide delta, and then onto the beach on the other side of the inlet. When inlets are temporary, as most are except near major river outflows, they soon become choked with sand and eventually close. The flood tide delta then becomes the base for new salt marshes, and a new surface onto which the barrier island may eventually retreat. We have found that most of the salt marshes behind retreating barrier islands, such as those found in the U.S. from North Carolina to New England, were created by old inlets. Many of these inlet sites are less than 100 years old, and most are less than 50.

Sand transport over a barrier beach can occur either by water or by wind. During major storms, especially along exposed shorelines with low tide ranges, surges of water crest over the beach and inundate the whole barrier except for the highest dunes. Sand is carried from the beach face to the backshore, and dunes erode along the barrier front. Where dunes are relatively high, breaks may occur in the intermittent areas. During the storm, wave swash can overtop the barrier; this process is called "overwash." The process is most frequent on exposed beaches which are oriented in such a way that prevailing winds do not build large dune systems.

It is also most common where tide ranges are relatively narrow and thus a storm surge can rise over the beach at any tide stage. Where tide ranges are wide, storm surges have to arrive at high tide in order to crest the beach. Where overwash transport is a major factor in the environment, barrier beaches are relatively low and flat, with scattered dune systems.

We have found that certain barrier islands which experience regular overwash have vegetation that is highly adapted to this process, with grasses and other plants which grow right up through the new deposits of sand that are laid down on the backshore. The Outer Banks of North Carolina have excellent examples of overwash adapted grasslands. Where overwash is not a major factor these grass species are not present. We have found that overwashes which occur occasionally on northern beaches are recolonized by dune strand species which are carried in during the flood, deposited in drift lines, and then regenerate to create a new dune system further back from the earlier dunes. Whatever the mechanisms of vegetative recovery, overwash is a major means by which certain barrier beach systems retreat, while in other areas it is only a minor process that occurs during the most severe storms.

Wind transport is the process which has received the greatest attention by ecologists. Where exposed beaches can be crossed by winds that exceed 4 metres/sec, sand will be moved off the beach. The winds move the sand roughly in proportion to their velocity cubed: low wind speeds move the sand grain by grain along the surface while higher winds can actually pick the sand up and move it through the air. Strong winds also can move wet sand off a beach, even when it is raining. The sand will move until the wind reaches an object or series of objects which slow it and allow the grains to fall out. The most effective sand trap on beaches and dunes is beach grass or other similar plants.

When vegetation is present, the dunes become stabilized and are held where formed unless some event breaks the plant cover and exposes the sand to further wind transport. In some cases, formerly stabilized dunes may begin migrating more rapidly than natural grass growth can keep up with, and this can lead to large, open dunes that migrate over the barrier beach, burying anything in their paths and exposing the remains of older habitats once they move on. Examples of migrating dunes can be found on almost every sandy coast, with good examples to be found in Oregon and parts of California, the Nags Head region of the North Carolina Outer Banks, the Province Lands of Cape Cod, portions of the English coast, a few regions in Holland, Doñana in Spain, and along the Australian coast.

Some Management Guidelines

It is essential to understand the physical and biological processes which create and maintain barrier beach ecosystems when planning for any form of human use. Oftentimes these connections are not made by planners, and we end up with expensive damage to natural systems.

Any action which interferes with the movement of sand along beaches leads to major problems. While groins and jetties are often used to prevent erosion and stabilize a beach or inlet, they frequently result in more erosion on the downdrift side of the structures. Anything placed across the littoral drift will catch sand on the updrift side, while the downdrift regions erode. Examples abound along any developed shore. Groins and jetties often create greater problems than they were designed to alleviate.

Where islands are retreating because of overwash and new inlet formation, attempts to stop such retreat have been expensive and especially hazardous. Overwash flooding, when it occurs, is a necessary part of the system, and building dune dikes to protect permanent installations only postpones the inevitable flood, which then results in great losses of property and often lives. Nothing can really stop those shorelines which are retreating, unless the existing oceanic environment changes, and any structures placed in the way are doomed to eventual destruction. Millions of dollars have been spent in the U.S. to stabilize and prevent shoreline retreat, yet the problem still exists and, in many areas, is much worse in spite of the engineering attempts. Preventing the formation of new inlets can also jeopardize the continued redevelopment of new tidal marshes and a general widening of the islands that usually results where barriers are retreating.

Of course, not all shorelines experience the same patterns of retreat, as mentioned earlier. When developing management programs for barrier beaches it is essential to keep in mind that one policy may not be applicable to all types of situations. Management plans should be made according to geological and ecological conditions, the anticipated use patterns, and the past human history of the areas being considered. For most purposes, it is better to let the natural processes operate than to interfere with them, but while "working with the system" is the best overall approach to planning for a coastal park, certain specific recommendations can be made that relate to erosion changes and human impact.

For Problems Relating to Beach Erosion

1. If at all possible, complete islands, or spits and associated uplands, should be included within the boundaries of the park, rather than bits and pieces. The best management program can be made when the boundaries of a coastal park include as complete a geological system as possible. In complete systems erosion on one part is usually compensated for by accretion in another. Natural forces can work without hindrance if the whole barrier beach is contained within a single unit and managed as a system. Developed inholdings, e.g., private facilities predating the park, always lead to difficult management problems.

2. Any necessary developments such as management structures or recreational facilities should be minimal, easily replaced,

Dune stabilization projects at the Kennemerduinen National Park in The Netherlands are visible at the left and center of this photo. Natural dunes are in the background. Photo: Paul J. Godfrey

and located in geologically stable areas. The beach front should be avoided wherever evidence shows that the areas have a history of change. Major park facilities for barrier islands are best located on the mainland, or the uplands well back from any eroding shore and migrating spit, or be built on pilings if in a flood-prone area. Detailed geological studies should be made, particularly dealing with erosion trends, before any plans are made.

3. No structures should be placed in the path of littoral currents and sand movement along the beach. Groins, jetties and sea walls will create major problems in those areas where sand transport along the beach is important to the existence of the barrier. Where inlets are stablized, or designs for doing so are promoted, provisions must be made for sand transport around the structures. Such plans will necessarily involve a type of "beach nourishment" program for the beaches downdrift of the jetties. Sand could be obtained from maintenance dredging that might be needed in the inlet, or on the updrift side of the jetties. However, such operations are costly and will have to continue as long as the structures exist.

4. Whenever possible, avoid developing parks in areas that are severely affected by outside influences such as distant groins and jetties unless some agreements are made with appropriate agencies to help alleviate these outside problems. Otherwise, the program and budget of the park may be severely taxed by attempting to correct the problems inherited from outside developments.

5. Avoid any erosion control projects that will tend to create a false sense of security—either for private inholdings behind the project, or visitors in the park. The greatest problem caused by erosion control programs over the years at Cape Hatteras National Seashore, for instance, was not so much the geological and ecological changes that resulted, but the false security created in areas outside the park boundaries. Dune building projects were done on park land after the Seashore was given management authority for the beach in front of many privately-owned areas. The dunes that resulted allowed developers to move seaward with permanent houses and communities, something which old time residents knew was folly. Yet even with the dunes eroding in many places, developers and home buyers (many from inland areas) still think the man-made dunes will stop the sea and that their investment is safe. Every effort must be made in public relations and education to point out that any erosion control project is only a temporary solution at best and can only slow down the inevitable retreat of the beach.

Certain projects which are designed to alleviate man-made problems, such as dune destabilization, can restore natural stability and therefore security from sand burial. However, these programs can only restore security where the natural system and historic development of the site allow stability to exist.

6. Certain forms of erosion control—whether designed to control beach retreat, dune migration, or other major forms of instability—can be successful to varying degrees when natural methods are used. In those areas that are currently in a stage of accretion and dune building, fostering the process by planting dune grasses, and some initial sand fencing and fertilization, has been shown to be a very successful management tool. Such natural methods are especially valuable where human disturbance has resulted in massive dune migration problems.

Besides planting dune grasses, other native plants can be used to restore vegetated regions where needed or desired. Those areas which are presently barren of natural plant communities which could prevent or slow down sand loss might be planted with appropriate species. The early development of man-made dunes across many formerly barren areas of Cape Hatteras National Seashore led to the formation of natural plant communities which are tolerant of and adapted to overwash flooding and burial. In some cases, the appropriate species (particularly salt meadow cordgrass, *Spartina patens*) were planted on the barren flats, and have led to more or less natural grassland.

Intertidal grass species can be planted on dredge spoil islands, or along lagoon shores where erosion is a problem. Stabilization of spoil islands prevents redistribution of the sand back into channels. Such activities can lead to viable salt marshes which add greatly to the stability and productivity of lagoon habitats.

For Problems Relating to Pedestrians

Many large areas of migrating dunes which subsequently bury other habitats of concern are the result of human misuse. Studies of the migrating dunes of Province Lands on Cape Cod have shown that these classic examples of parabolic dunes were destablized by human activities following settlement in the 1600's. This area was once well-forested. Cutting of timber, creation of open grazing land, wild fires, and related influences, broke the vegetative cover, and caused massive blowouts which released the dunes. Continued use by large numbers of people and off-road vehicles contribute to the instability of these dunes.

Heavy pedestrian traffic can lead to significant deterioration of stabilizing dune vegetation. Studies done on Cape Cod, the British Isles, Denmark and elsewhere have been directed toward assessing this impact.

Suggestions:

1. In areas of moderate dune use, mark trails clearly and use native shrubs to create borders which can discourage people from widening the path. Roses, bayberry, and other rather impenetrable shrubs make good and often attractive trail borders.

2. Where heavy use is likely, wooden walkways and bridges over sensitive dune vegetation should be built over the dunes to the beach. Such elevated walkways are essential in wetland and salt marsh habitats. Good examples of elevated trail systems can be found on Fire Island National Seashore and parts of Cape Cod National Seashore. Most other parks which have heavy trail use are turning to elevated paths made of wood.

3. Most people climb high dunes to get a view, and hence

A boardwalk built over the dunes at Fire Island National Seashore, New York, U.S.A. Where use is heavy, boardwalks will help control damage. Photo: Paul J. Godfrey

Open dunes and an off-road vehicle track at Cape Cod National Seashore, Massachusetts. Pilgrim Lake appears at the right. Photo: Paul J. Godfrey

increase the instability of these high spots, often causing severe damage. A few wooden platforms and access steps in heavy use areas can significantly reduce this problem.

4. Maintain public information programs, explaining why heavy traffic on dunes creates problems.

For Problems Relating to Off-Road Vehicles

The uncontrolled and increasing use of beaches and dunes by visitors with off-road (four-wheel drive) vehicles can lead to major destabilization problems. Dune vegetation has a low tolerance to vehicle impact and when the plants are killed by vehicles, blowouts soon result. Recent studies done by the University of Massachusetts/National Park Service Cooperative Research Unit on Cape Cod show that fewer than 50 vehicle passes are sufficient to kill beach grass vegetation and lead to an open track. Traffic on beaches where new dunes normally form can prevent the development of new dune lines which ordinarily provide more stability. We also determined that intertidal salt marshes and the organisms of sand flats have a very low tolerance to vehicle impacts. The intertidal ocean beach showed the greatest tolerance of all the habitats we experimentally impacted, but other considerations must be taken into account when evaluating these results. Our studies were done on a northern beach where intertidal organisms are rather few. Similar beaches farther south, which have large populations of intertidal marine animals, can be severely affected by traffic.

Where birds use beaches for nesting and feeding, vehicle impacts can be very significant, especially where beaches are narrow. Nesting-bird colonies can be badly affected. Heavy traffic in vacant nesting sites can prevent birds from returning at nesting time, especially where the traffic is widespread over the beach. For more information regarding the management of coastal birds, refer to Buckley (1976).

Suggestions:

1. The best management approach to solving vehicle problems is not to open areas that have been closed or have previously been inaccessible. Provide controlled, public transportation to inaccessible areas, if really necessary, or encourage visitors to walk.

2. Where vehicles must be allowed for any compelling reason, certain management procedures can be followed:

a. Prevent indiscriminate traffic on dunes.

b. Restrict traffic to marked routes along which borders of cable, or dense shrubs, are established after careful study.

c. Vehicle tracks must be controlled and maintained. Deterioration of the track (such as development of washboard ruts) often will spur drivers to go off the established path and create new ones.

d. Restrict traffic to intertidal ocean beaches where surveys show relatively few marine animal populations are present. Where possible a marked route should be established on the berm to prevent indiscriminate driving over the beach zone.

e. Route traffic on the beach around sites of significant dune formation, particularly where driftlines and seeds accumulate.

f. Prevent all traffic across salt marshes and intertidal flats, or along the borders between marshes and sand dunes.

g. Close off overwash passes between dunes and prevent vehicle use of these openings. Such passes eventually close and develop new dune systems. Vehicle traffic will prevent the natural processes from closing the gaps.

h. Ramps should be built over dunes where access to the beach is desired. Once built, such ramps will require periodic maintenance, especially following storms.

i. Close off bird and marine turtle nesting sites and important feeding areas. Appropriate signs which explain the need for protection should be erected at some distance from the actual nesting sites. People on foot, leaving a vehicle to read a small sign near a nesting area, can cause more disturbance than a vehicle passing in front of the colony.

j. Close beaches to vehicles during periods of exceptionally high tides, which would force drivers to run up the face of dunes, often through nesting sites and incipient dune areas.

Basic Research and Management

Applying basic research to the needs of park management can be a very important exercise for both the researcher and the manager, although they often have different objectives. It is almost axiomatic that one needs to know how a natural system, such as a barrier beach, operates before one can manage it, yet the reverse has often been more common. However, today it has become quite clear that research and management should move together and that continuous dialogue and information transfer between managers and scientists is of mutual benefit. Our basic understanding of how the vegetation of barrier islands is adapted to overwash and migration, and the significance of the migration processes, has come from basic research supported by the National Park Service. In these projects, which were carried out through the NPS Cooperative Research Unit at the University of Massachusetts, and now in other institutions as well, new information was gathered, and new models were created to determine how the natural system operates. That process is still under way. Yet the main impetus of the research was management oriented. For example, the work we did on the Outer Banks was directed towards developing a basic understanding of barrier island ecology so that a new park, Cape Lookout National Seashore, one that is basically wild and undeveloped, could be better managed on the basis of research and experience.

Each year there are more scientists interested in coastal areas and their management problems. A recently held conference at the University of East Anglia in Norwich, England, brought together for the first time ecologists from Europe, Australia, New Zealand, Canada, the United States, and other countries to consider ecological research in coastal areas. Much of the research was basic in nature, but a considerable portion dealt specifically with management problems. As a result of this meeting, an international group of scientists concerned with human impacts on sand dunes was formed. In 1976, the NPS sponsored a conference on research in the

National Parks that was attended by both researchers and managers. A conference sponsored by the Georgia Conservancy and Barrier Island Coalition was held in early December, 1977. Scientific- and management-related problems of dealing with barrier islands were considered at this meeting attended by scientists, lawyers, Park Service, as well as other federal, state and private resource managers, interested lay people, and others who are involved with coastal problems. Such interaction is essential for effective programs for managing coastal resources.

Governments that are now creating coastal parks might follow a similar approach and include local scientists in planning operations for these parks. By doing so early in the process, management mistakes might be avoided, while at the same time improving research programs. Such interaction can lead to a much sounder program for management of an increasingly threatened resource, the barrier beaches of the world.

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Hans Köpp and Ali Yachkaschi

Development and Status of Protected Areas in Iran

The second edition of the *United Nations List of National Parks and Equivalent Reserves* of 1971 still contained no actual names of protected areas in Iran but there were a number of important indications as to their status.

At that time "Protected Regions" were mentioned in which agricultural activity was restricted but in principle not excluded. Thus hunting and fishing were allowed with the permission of the then Game and Fish Department in Tehran, and also agriculture, grazing and timber felling, with the permission of the Ministry of Agriculture and the Department of Hunting. At the end of 1965 there were 11 such protected regions with a total area of 600,000 ha.

Furthermore, legislation of that period envisaged the creation of "Wildlife Parks", areas which, in contrast to the Protected Regions, were exclusively owned by public authorities, in this case the Game and Fish Department. Here farming and stockbreeding were forbidden, but hunting and fishing were allowed under certain conditions.

In 1965 there was only one such reserve. This was the Mohammed Reza Shah Wildlife Park in northeastern Iran, covering an area of about 100,000 ha of mainly mountainous and partly wooded country. There, together with a wide variety of bird life, were to be found a species of wild pig *(Sus scrofa)*, Urial sheep *(Ovis ammon arkal)*, Persian ibex *(Capra aegagrus)*, leopard (*Panthera pardus*), brown bear (*Ursus arctos*), goitered gazelle (*Gazella subgutturosa*) and maral (*Cervus elaphus*), a regional race related to the European red deer. Also until 20 years ago, the Caspian tiger was present in very small numbers. It must be regarded as extinct in Iran as no occurrence of it has since been reported. Changing habitat and illegal trapping, particularly the use of poisoned bait, by the local populace were factors which also led to the extinction of that great cat long after the disappearance of the Persian lion (*Panthera leo persica*). Other species, which have not been able to stand up to the pressure of hunting and changed agricultural methods, have been brought to the verge of extinction. These include above all the cheetah (*Acinonyx jubatus*), the Persian fallow deer (*Dama mesopotamica)*, the black bear (*Selenarctos thibetanus*) and *Equus hemionus*, the Persian wild ass. (Harrington 1977).

"Hunting Centres" were founded in the first instance on the initiative of a very few hunters for the protection of endangered species. The idea was that, in order to be able to control hunting, the possession of a hunting license should be made compulsory. In 1966, following this private initiative, the Game and Fish Department was then established and this organization declared certain areas as national parks and as equivalent reserves for the protection of flora and fauna. Because of the increase in population—at the moment Iran has about 34 million inhabitants and steadily growing high density areas, particularly in Tehran and in the north of the country—and because of the rapid development of industry, the tasks of that organization were considerably expanded, and in 1971 the Game and Fish Department was enlarged to become the Department of the Environment (Yachkaschi 1976).

The supplement to the second edition of the *United Nations List of National Parks and Equivalent Reserves* (Harroy 1972) lists five Wildlife Parks, covering a total of 211,700 ha. These are (1) Mohammed Reza Shah W.P., 91,890 ha; (2) Tandoureh W.P., 73,435 ha; (3) Kolah Ghazi W.P., 41,000 ha; (4) Dez W.P., 3,837 ha; and (5) Karkheh W.P., 1,538 ha. Meanwhile the first two of these five parks have been declared National Parks and the second two have been considerably enlarged in area. At the time of its publication two further Wildlife Parks already existed but because of their small area they were not incfuded in the UN list: (1) Dash-i-Naz W.P., 55 ha, (2) Khoshkedaran W.P., 227 ha. The latter park in North Iran has since been officially declared as one of the four "National Nature Monuments."

At that time four important wetlands were already included in

Overgrazed and overexploited, the devastated cupressus forests in the Central Alborz Protected Region, North Iran, are now strictly protected. Photo: A. Yachkaschi.

Central Alborz National Park. Vegetation and minor settlements are mainly limited to valleys having streams or rivers. Photo: A. Yachkaschi.

the Protected Regions. With a few exceptions, hunting in the wetlands is forbidden. However, a limited degree of settlement and agriculture was permitted, in each case subject to a strict but not easily enforceable control.

Wildlife Parks (meanwhile renamed "Wildlife Refuges") enjoy in the main the same degree of protection as the National Parks but for them a restricted measure of hunting based on the principles of modern scientific wildlife management is explicitly planned under state control and limited to specially authorized persons. While hunting in these protected areas can be more or less controlled, outside the reserves more game continues to be killed than is authorized by law.

The rapid development and expansion of protected areas in Iran are shown by the *1974 United Nations List of National Parks and Equivalent Reserves* (UN 1974), in which are registered 12 Protected Regions—4 National Parks and 8 Wildlife Refuges—with a total area of over 1 million ha, of which, however, two are of purely provisional character. These figures reflect the development from 1962 to the beginning of the 1970's.

Iran attracted the attention of the world on the occasion of the United Nations Conference on the Human Environment (Stockholm 1972). In order to encourage international co-operation in the field of nature conservation, the Iranian government offered to cede its sovereignty in the "international" park Sashte Argan, an area of 65,750 ha west of Shiraz in South Iran, in favor of an international control.

Just as there has been tremendous economic and industrial growth, accompanied by serious problems of environmental

Table 1: National Parks (1977)

1. Mohammed Reza Shah	125,895 ha
2. Lake Rezaiyeh	463,600 ha
3. Central Alborz	56,250 ha
4. Bamou	48,075 ha
5. Kavir	790,625 ha
6. Tandoureh	53,780 ha
7. Sarani	17,800 ha
8. Argan	65,750 ha
9. Geno	81,230 ha
10. Hara	85,686 ha
11. Lar	73,500 ha

Source of tables: Department of the Environment, Tehran.

Restaurant and tourist facilities in a forest park near the Caspian Sea, northern Iran. Photo: Hans Köpp.

Table 2: National Nature Monuments (1977)

1. Central Alborz	11,000 ha
2. Khoshkedaran	227 ha
3. Dehloran	1,400 ha
4. Lilium Ledebourii	0.6 ha

Table 3: Protected Regions (1977)

1. Dez	10,633 ha
2. Karkheh	9,427 ha
3. Central Alborz	332,126 ha
4. Parvar	59,840 ha
5. Mooteh	159,200 ha
6. Shah-Kuh	26,600 ha
7. Marakan	92,715 ha
8. Bisotoun	50,850 ha
9. Bazman	324,688 ha
10. Lisar	31,250 ha
11. Haftad-Gholle	82,125 ha
12. Oshtrankooh	93,950 ha
13. Tang-e-Sayad	27,000 ha
14. Angouran	96,130 ha
15. Bijar	72,640 ha
16. Bahukalat	382,430 ha
17. Arasbaran	34,145 ha
18. Bahram-e-Gour	385,000 ha
19. Touran	1,295,400 ha
20. Shah-Jahan	28,000 ha
21. Salook	16,000 ha
22. Jahan-Nema	30,650 ha
23. Babolkenar	1,133 ha
24. Mormod	151,284 ha

Table 4: Wildlife Refuges (1977)

1. Kharko	312 ha
2. Dez	5,240 ha
3. Karkheh	3,600 ha
4. Khosh-Yeilagh	166,880 ha
5. Dash-i-Naz	55 ha
6. Mooteh	132,720 ha
7. Bisotoun	31,250 ha
8. Siahkesheem	6,701 ha
9. Hamoun	193,500 ha
10. Bakhtegan	327,820 ha
11. Miankaleh	68,800 ha
12. Kolah Ghazi	48,683 ha
13. Selke	360 ha
14. Amirkelayeh	1,230 ha
15. Angouran	28,600 ha
16. Khabr-va-Rouchoon	173,750 ha
17. Mehrouyeh	7,468 ha
18. Ghamishloo	49,250 ha
19. Sheedvar	160 ha
20. Arasbaran	38,320 ha
21. Touran	515,000 ha
22. Shadegan	296,000 ha
23. Kiamaki	84,400 ha
24. Semeskandeh	937 ha
25. Miandasht	52,000 ha
26. Fereidoonkenar	148 ha
27. Astara	949 ha
28. Dodangeh	6,700 ha
29. Mond	46,700 ha
30. Helleh	42,600 ha
31. Latian*	110 ha

* Area approved, but not yet announced.

pollution and socio-economic changes, so also has there been in recent years a considerable extension in the work on protected areas, and it has been possible, above all, to safeguard the endangered species (Ovington 1972).

Because of its wide variety of geological, geomorphological, topographical and climatic conditions, and a total surface area of 1.6 million sq. km, Iran can boast of an equally wide variety of flora and fauna and their ecological communities, and natural resources in general. With the exception of the desert regions of central Iran and the eastern regions on the Afghanistan frontier, the present system of regional protection, which is in the process of being expanded, does its best to safeguard representative biotopes and habitats of threatened and endangered species, particularly fauna (Firouz 1974).

At the present there are 69 protected areas covering a total of almost 8 million ha (7,998,168) or 5 percent of the land surface. This does not include protected and recreational woodlands of the Forest Service and other jurisdictions, for instance those on the coast, which are maintained exclusively for leisure time activities, such as recreation and tourism. The protected areas are divided into 4 categories:

1. National Parks: 11 with a total of 1.8 million ha
2. National Nature Monuments: 4 with a total of only 12,267 ha.
3. Protected Regions: 24 with a total of 3.8 million ha
4. Wildlife Refuges: 30 with a total of 2.3 million ha

The majority of the protected areas fall into only one of the categories; 7 of them include both Protected Regions and Wildlife Refuges in the area they cover. In one case, namely that of the Central Alborz between Tehran and the Caspian Sea, categories 1, 2 and 4 are represented.

To date there are no bi-laterally protected areas although, particularly with Pakistan and Turkey, nature conservation projects are being agreed upon on the basis of joint conferences and there already exist protected areas which border on the neighboring countries of Pakistan, Afghanistan, USSR and Iraq.

It is still too early to provide a time schedule for the final and complete establishment of all the above mentioned protected areas. Some still have not been alloted fixed boundaries. It will take some years before they are classified according to the present system, zoned and effectively protected. In order to accelerate this work, Iran is taking steps, with some assistance from the UN, to train sufficient staff experts. This is an essential measure if the many nature conservation targets are to be met. It has become evident that the adoption of specific foreign models has its limitations; in the selection of protected areas the typical and characteristic development of the country must be taken into consideration. Also a national park without the possibility of access for the public by zoning is as out of date as the attempt to evacuate the resident peasant population in the protected areas. Meanwhile the first plans for national parks based on these principles are available.

In addition to protected land surface areas, the rivers Chalus, Sardab, Karaj, Jairud, Car and Harraz as well as all wetlands (marshes, lagoons and bays) on the Caspian Sea are protected as are also the rivers in the provinces of Gilan and Mazandaran which flow through lagoons or directly into the Caspian Sea. Furthermore, hunting is forbidden in three districts with a total area of 130,000 ha in the provinces of Eastern Azerbaijan and Hamadan.

Iran is still far from being able to achieve the aims she has laid down for herself. Nevertheless, in recent times the responsible authorities have shown themselves increasingly determined to implement all the measures that are within their power to accomplish.

Demawand, an ancient volcano located northeast of Tehran, is in the Central Alborz Protected Region some 150 km south of the Caspian Sea. It is always covered by snow and ice and at 5,774 m is the highest peak in Eurasia west of the Hindu Kush. Photo: A. Yachkaschi.

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Criteria for Inclusion in the World Heritage Lists

The following criteria were adopted by the World Heritage Committee at its first meeting last June. These paragraphs were extracted from the document entitled "Operational Guidelines for the World Heritage Committee" and are reprinted on these pages as a service to the readers of PARKS Magazine.

Criteria for the inclusion of cultural properties

9. Outstanding universal value will be recognized when a cultural property, as defined in Article 1,* submitted for inclusion in the World Heritage List is found to meet one or more of the following criteria. Therefore each property should:

(i) represent a *unique artistic* or *aesthetic* achievement, as a masterpiece of the human creative spirit;

(ii) be of *outstanding importance* owing to its influence, over a span of time or within a cultural area of the world, on subsequent developments in architecture, monumental sculpture, garden and landscape design, or human settlements;

(iii) be *unique, extremely rare* or of *great antiquity*;

(iv) be among the *most characteristic* examples of a type of structure, the type representing an important cultural, social, artistic, technological or industrial development;

(v) be a *characteristic example of a significant* traditional style of architecture, method of construction, or human settlement, that is fragile by nature or has become vulnerable under the impact of irreversible socio-cultural or economic change;

(vi) be *most importantly* associated with ideas or beliefs, with events or with persons, of outstanding historical importance or significance.

10. (a) In every case, consideration should be given to the state of preservation of the property (which should be evaluated relatively, that is, in relation to property dating from the same period and of the same type and category).

(b) In addition, the property should meet the test of *authenticity* in design, materials, workmanship, and setting; authenticity does not limit consideration to original form and structure but includes all subsequent modifications and additions, over the course of time, which in themselves possess artistic or historical values.

Criteria for the inclusion of natural properties

11. Outstanding universal value will be recognized when a natural heritage property as defined in Article 2*, submitted for inclusion in the World Heritage List is found to meet one or more of the following criteria. Therefore properties should:

(i) be outstanding examples representing the *major stages of the earth's evolutionary history*. This would include sites which represent the major "eras" of geological history such as "the age of reptiles" where the development of the planet's natural diversity can well be demonstrated and as the "ice age" where early man and his environment underwent major changes;

(ii) be outstanding examples representing significant on-going *geological processes, biological evolution and man's interaction with his natural environment*. As distinct from the periods of the earth's development, this focuses upon on-going processes in the development of communities of plants and animals, landforms and marine and fresh water bodies. They would include, for example, a) as geological processes, glaciation and volcanism, b) as biological evolution, biomes such as tropical rainforests, deserts and tundra, c) as interaction between man and his natural environment, terraced agricultural landscapes.

(iii) contain *unique, rare or superlative natural phenomena, formations or features or areas of exceptional natural beauty*, such as superlative examples of the most important ecosystems to man, natural features (rivers, mountains, waterfalls), spectacles presented by great concentrations of animals, sweeping vistas covered by natural vegetation and exceptional combinations of natural and cultural elements,

(iv) *be habitats where populations of rare or endangered species of plants and animals still survive*. This would include those areas where concentrations of plants and animals of universal interest and significance are found.

It should be realized that individual sites may not possess the most spectacular or outstanding single example of the above, but when the sites are viewed in a broader perspective with a complex of many surrounding features of significance, the entire area may qualify to demonstrate an array of features of global significance.

12. In addition to the above criteria, the sites should also meet the conditions of *integrity*.

(i) the areas described in 11. (i) should contain all or most of the key interrelated and interdependent elements in their natural relationships; for example, an "ice age" area would be expected to include the snow field, the glacier itself and samples of cutting patterns, deposition and colonization (striations, moraines, pioneer stages of plant succession, etc.),

(ii) the areas described in 11. (ii) should have sufficient size and contain the necessary elements to demonstrate the key aspects of the process and to be self-perpetuating. For example, an area of "tropical rain forest" may be expected to include some variation in elevation above sea level, changes in topography and soil types, river banks or oxbow lakes, to demonstrate the diversity and complexity of the systems,

(iii) the areas described in 11. (iii) should contain those ecosystem components required for the continuity of the species or of the objects to be conserved. This will vary according to individual cases; for example, the protected area for a waterfall would include all, or as much as possible, of the supporting upstream watershed; or a coral reef area would be provided with control over siltation or pollution through the stream flow or ocean currents which provide its nutrients,

(iv) the areas described in 11. (iv) should be of sufficient size and contain the necessary habitat requirements for the survival of the species.

For earlier publications on this subject see PARKS Vol. 1, No. 1 (April, May, June 1976) and PARKS Vol. 2, No. 3 (October, November, December 1977). Additional information, nominating forms and instructions can be obtained by Members States from the Division of Cultural Heritage, UNESCO, 7 place de Fontenoy, 75700 Paris, France.

* of the Convention.

PARK PRACTICE

Repointing Mortar Joints in Historic Brick Buildings

Robert C. Mack, A.I.A.

The following material is reprinted from Preservations Brief No. 2, *Interagency Historical Architectural Services Program, Office of Archeology and Historic Preservation, U.S. National Park Service. It serves as a model that could be adapted by other countries for their own cultures and geographic locations.—Ed.*

Repointing, also known as "tuck pointing" or simply "pointing," is the process of removing deteriorated mortar from the joints of a masonry wall and replacing it with new mortar. The selection of improper techniques or materials in the repointing of historic buildings not only can alter the visual aspects of a building but also can lead to further deterioration of the masonry. The purpose of this publication is to provide general guidance on the methods and materials for the repointing of historic brick buildings, for the benefit of building owners, architects and craftsmen.

Identifying the Problems

The decision to repoint usually is related to some perceptible problem, such as falling mortar, loose bricks or damp walls. The actual cause of the problem, however, may be unrelated to the visible effects, and for this reason *the services of an architect or preservation consultant should be obtained at the earliest planning stages to prevent both visual and physical damage to the building.*

The first step in planning a repointing project is to ascertain the true causes of problems which need attention. If the reason for repointing is to stop water penetration, the consultant should thoroughly investigate all possible sources of water. Damp walls may be caused by leaks from parapets, flashing, or roofs, and such leaks may show up some distance below in the masonry walls. Another source is rising capillary moisture which can cause dampness several feet above the ground. In either of these cases, repointing the outer masonry wall will not cure the problem. Similarly, if open joints or loose bricks are caused by foundation settlement or deterioration of materials, such structural problems should be corrected before beginning masonry work. After such an investigation, the consultant can inform the owner of necessary remedial actions and their costs, possibly including additional technical advice from foundation or soil engineers.

Logistical planning: It is important to recognize that repointing will be an expensive and time-consuming task due to the large amount of handwork and special materials required. Work cannot begin immediately, because research is required and some materials such as handmade bricks may have a long delivery time. Scaffolding will be in place for an extended period, possibly interfering with normal circulation patterns. The owner should remember that many communities will require a building permit before work can begin.

The architect/consultant also must recognize logistical considerations and the relationship of the repointing to other proposed work. For example, if paint is to be removed or gutters replaced, it may be logistically advisable to conduct research relating to these items before beginning to repoint. If water penetration is to be corrected, the repointing work probably should come early in the preservation project; if the building is watertight, it may be better to wait until after completion of exterior cleaning so that the existing and new mortars will weather simultaneously. Related projects, such as installing downspouts or painting (possibly separate contracts) should be scheduled to avoid conflict with the repointing work but at the same time to take maximum advantage of the scaffolding. Contractors should be made aware of these various architectural and logistical relationships in the early stages of project planning.

Research

The repointing work will possibly involve analysis not only of the mortar but also of the bricks and the techniques originally used in striking the joints.

Mortar study or analysis is necessary if the repointing mortar is to match the original mortar in color, texture, and other properties. The identification of the major constituents is relatively simple; it may be possible to arrive at an approximation of the mortar's composition by observation (using low magnification) of an unweathered sample. (A more accurate method for performing this analysis is presented by E. Blaine Cliver in "Tests for the Analysis of Mortar Samples" in the *Bulletin* of the Association for Preservation Technology, Volume VI, Number 1, 1974. This article describes a methodology for separating a mortar sample into its various components.) Once the constituents have been separated and identified, the same can be examined for the range of color, size and shape of the grains. Other insoluble materials also should be identified for inclusion in the repointing mortar.

Pointing styles and the methods of producing them should be studied (Fig. 1). It is important to examine both the hori-

zontal and vertical joints to determine which were struck first and whether they are the same style. Some buildings, for example, have horizontal joints which were tooled concave while the vertical joints were finished flush with the surface of the brick, then stained to match the brick, creating the illusion of horizontal bands. This technique was used extensively in late 19th and early 20th century architecture.

Bricks should be studied so that any replacements which may be necessary will match the originals. Within a wall there may be a surprisingly wide range of colors, textures, and even sizes. Replacement bricks should match this range rather than a specific brick. Potential sources for replacement bricks should be considered at the first stages because of the length of time required for the manufacture of special bricks. It may be possible to obtain suitable bricks from salvage building materials suppliers, or, if of comparable hardness and color, bricks may be moved from unexposed areas in the building to exposed areas.

Planning the Work

Properties of mortar: In general, repointing mortars should match the original mortar in constituent composition and proportions as well as in color and texture. The importance of matching the composition frequently is overlooked, yet this match is necessary if the new and old mortars are to have the same physical characteristics.

It is a common error to assume that hardness or high strength is a measure of durability. Stresses within a wall caused by expansion and contraction or by settlement must be accommodated in some manner; in a masonry wall these stresses should be relieved by the mortar rather than the brick. A mortar which is stronger and harder than the masonry units will not "give," thus causing the stresses to be relieved by the masonry units, usually in the form of cracking and spalling (Fig. 2). Uneven movement in the masonry also can break the bond between the mortar and the brick, opening hairline cracks to water penetration. Mortars with a high percentage of portland cement can have the above described deleterious effects. Additional information on this problem is contained in *Studies of Stone-Setting Mortars; Building Materials and Structures Report 139*, published by the National Bureau of Standards in 1953. Porous mortar permits water within the wall to migrate and escape. Mortar with a high cement content does not permit this movement, and the water trapped within the wall may be subjected to freeze-thaw cycles which can spall soft, older brick.

"Workability" or plasticity of the mortar also is important. The new mortar should have both cohesive and adhesive qualities to make complete physical contact with the masonry and old mortar.

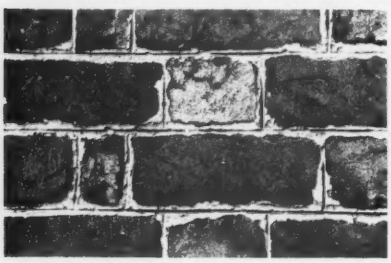
It should have the maximum amount of sand consistent with such workability to help reduce shrinkage while drying. The mortar must not be sticky or gummy and must handle readily on the pointing tool. Finally, the newly applied mortar must have good water retention to resist rapid loss of water through absorption by the brick or old mortar while setting.

Advantages of using high lime mortar: These facts lead to the conclusion that a high lime mortar generally is best for most historic structures, even those originally constructed with cement mortars. High lime mortar is soft and porous, and has the lowest volume change due to climatic condition. In addition, lime mortar is slightly soluble in water and able to self-seal small cracks and voids that may develop. In this phenomenon, a slight amount of the mortar dissolves in rain water and is precipitated in the void during the drying process, thus sealing the crack. Even straight lime mortar is more durable than generally recognized as long as the wall is protected from water penetration with sound roofing, gutters, flashing, etc. A small amount of white portland cement may be desirable, however, to accelerate setting.

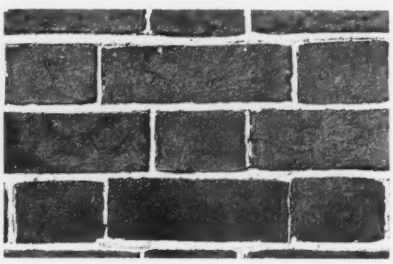
Even if the building originally was constructed with cement mortar, it usually is best to use a high lime mortar rather than match the original. High lime mortar will reduce potential stresses at the edges of the masonry and also help minimize shrinkage, which leads to hairline cracking.

Matching color and texture: Although the use of proper materials and techniques will give a watertight job, appearance is

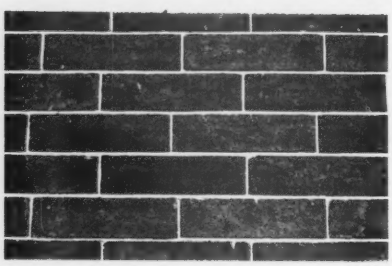
Figure 1. A variety of joint types and brick bonding patterns are illustrated here. Note the difference in uniformity of the bricks in A and B, which are handmade, and those from C through F, which are machinemade. It is evident in A, B, and F that the vertical joints were struck before the horizontal joints. Also note in B and E that the vertical joints are narrower than the horizontals.



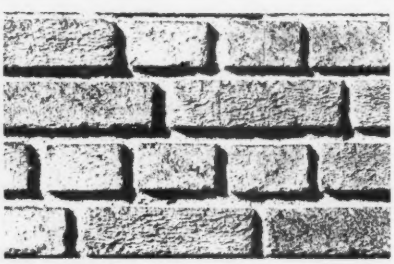
A Colonial grapevine joint, Flemish Bond ca. 1720.



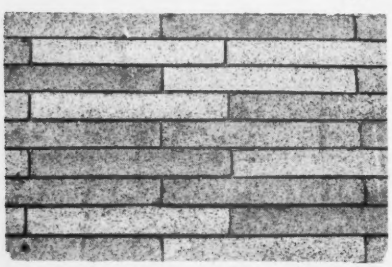
B Beaded joint, Flemish bond. ca. 1809.



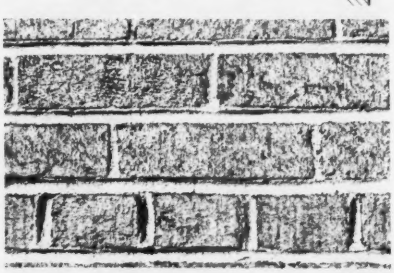
C Flush joint, common bond. mid-19th century



D Raked joint, English bond. early 20th century.



E Flush joint, one-third running bond. early 20th century.



F Concave joint, common bond. early 20th century.

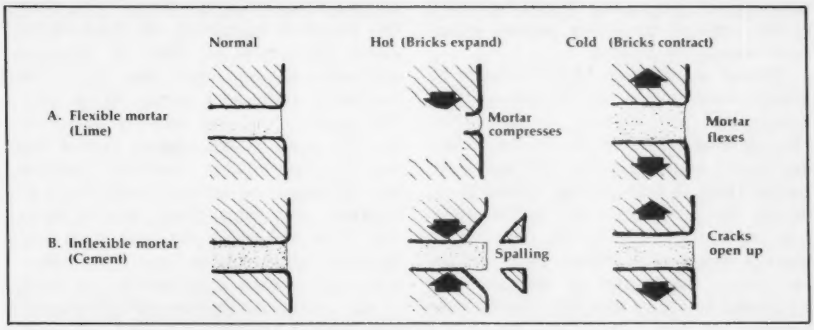


Figure 2. Diagrammatic sketches showing effects of temperature change upon masonry. Flexible mortar (A) expands and contracts with temperature changes. Bricks bonded by inflexible mortar (B) tend to spall at the edges (the area of greatest stress) in hot weather and separate from the mortar when it is cold. This latter condition opens cracks, permitting the entry of water and causing additional deterioration. Adapted from Maintenance of Old Buildings, *Document D 10; National Swedish Institute for Building Research, Stockholm, 1975.*

also important. Both color and texture most often can be matched through the careful selection of lime and sand or other aggregates. Every reasonable effort should be made to use these natural sources of color and texture in matching the mortar. If the original sand borrow pit is no longer available, the masonry contractor may know of similar sand available in the region.

If it is not possible to obtain a proper match through the use of natural materials, it may be necessary to use a mortar pigment. Of course, some late 19th and early 20th century mortars contained such colors. These pigments are available as a separate ingredient or already mixed with mortar cement and lime; the premixed mortars usually are not suitable for use on older structures due to the high portland cement content. Only chemically pure mineral oxides that are alkaliproof and sun-fast should be used; natural earths have low tinting values, organically based colors fade in direct sunlight, and carbon black dissolves out of mortars which are not impervious to moisture.

Texture of the mortar also affects the visual characteristics. Modern mortars are finely ground and thus present a uniform texture as well as color; early mortars were not as finely ground, however, and may contain lumps of oyster shell or incompletely burned lime. The size, color, and composition of these lumps should be determined as part of the mortar analysis, and they should be duplicated in the repointing mortar. These particles can be duplicated in kind with new oyster shells or lumps of lime, or they can be made by grinding the older mortar removed during the joint preparation and adding it to the new mortar.

Materials Specifications

Modern materials specified for use in repointing mortar should conform to specifications of the American Society for Testing and Materials (ASTM) or comparable Federal specifications.

Lime should conform to ASTM C 207, Type S, Hydrated Lime for Masonry Purposes, or Federal spec SS-L-351B. This lime is designed to assure high plasticity and water retention with a safe degree of strength. The use of quicklime with the necessity of slaking and soaking does not provide better results.

Cement should conform to ASTM C 150, Type I or II, or Federal spec SS-C-192G(3). It should have not more than 0.60% alkali (expressed as sodium oxide) or not more than 0.15% water soluble alkali by weight (in the combination of lime and cement). This low alkali content is necessary to help avoid efflorescence. Non-staining white cement is quite expensive but frequently will be required in lieu of the usual grey cement to provide the proper color.

Sand should conform to ASTM C 144, or Federal spec SS-A-281B(1) para. 3.1, to assure proper gradation and freedom from impurities. Sand color, size, and texture should match the original as closely as possible to provide the proper visual characteristics without other additives. A sample of the sand is necessary for comparison to the original, and should be approved by the consultant before beginning repointing work.

Water should be clean and free from deleterious amounts of acids, alkalis, or organic materials.

Special additives will require writing new specifications for each project. If possible, suggested sources for the special materials should be included. For example, crushed oyster shells frequently can be obtained in a variety of sizes from poultry supply dealers.

Mortar mix: As mentioned previously, the new mortar usually should match the existing mortar as closely as possible, and the best way to insure a match is through careful analysis of the existing mortar. If an accurate chemical match of the original mortar is not feasible, or if the original mortar is too hard for repointing work, the following mixes may provide a *starting point for the development of a mortar which is visually and physically acceptable.* If the original mortar was nearly all lime and sand, try by starting with the following mix:

1 bag hydrated lime
¼ bag white portland cement
3 cubic feet of sand to match the original
(note: 1 bag is equivalent to 1 cubic foot)

If the mortar originally contained cement, or for extreme weather exposures such as parapet walls, try:

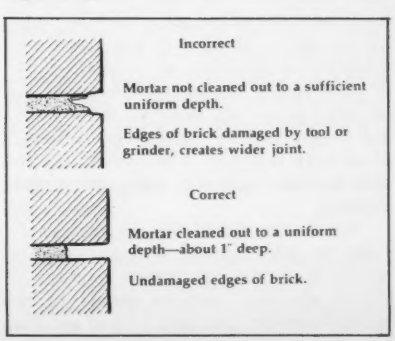
1 to 1½ bags hydrated lime
1 bag portland cement
5 to 6½ cubic feet of sand

Keep in mind that the above mixes are only given to suggest the basic range of lime-to-cement ratios. It is likely they will require modification or additional constituents before they produce a mortar that matches the visual and physical character of the original.

Execution Of The Work

Supervision: Repointing work on historic structures will require significantly more supervision than work on contemporary buildings in order to prevent unintentional damage to the brick. Craftsmen, contractors, and job supervisors should understand the reasons for the repointing work and the damage which can arise from improper techniques. Craftsmen must realize that the preservation of the bricks is more important than strong mortar or rapid progress, and that a great deal of hand labor will be required. Contractors should be aware that some materials may require long delivery periods while others may not be available through builders' supply companies at all. Contractors must also understand that "stop orders" may be authorized by the owner to permit further

Figure 3. Comparison of incorrect and correct preparation of mortar joints for repointing.


Incorrect
Mortar not cleaned out to a sufficient uniform depth.
Edges of brick damaged by tool or grinder, creates wider joint.
Correct
Mortar cleaned out to a uniform depth—about 1" deep.
Undamaged edges of brick.

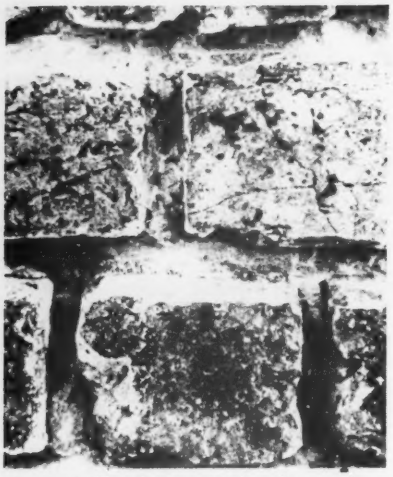


Figure 4. The damage to the edges and corners of these bricks was caused by using a power grinder in cleaning the joints. Extensive hand work is required to prevent damage to the bricks during joint preparation.

architectural research should unexpected conditions be revealed during the course of the project. Only after considering these factors will contractors be able to submit accurate bids which will afford a reasonable profit without pushing the craftsmen to produce a hasty job.

Joint preparation: Generally old mortar should be cut out to a minimum depth of one inch (2.54 cm) to insure an adequate bond between the new mortar and the existing masonry and to prevent mortar "pop-outs." For joints less than three-eighths (1 cm) of an inch thick, cutting the mortar back one-half inch (1.27 cm) usually is sufficient if the mortar behind that point is in good condition. Any loose or disintegrated mortar beyond this minimum depth should be removed (Fig. 3). Unless the mason is unusually skilled and extremely careful, the use of power tools for mortar removal inevitably will damage the brick (Fig. 4). Damage to the edges of the brick will significantly affect the character of the brickwork; in addition, absorption of water is increased since the softer inside of the brick is no longer protected by the hard burned outer surface. Where joints are uniform and fairly wide, and the bricks were machine-made with straight edges, it may be possible to use a grinder. A test patch will establish the feasibility of using a grinder. *If there is any chance of damage to the masonry occurring, however, hand methods should be used exclusively.* Although hand work is slower, it is easier to control and is less likely to cause irreversible damage.

The mortar should be removed cleanly from the brick leaving square corners at the back of the cut. Before pointing is started all loose particles should be removed from the joint with a jet of air. The masonry and old mortar should be wetted at the time of repointing but no excess water should be present.

Mortar preparation: Mortars should be mixed thoroughly to obtain uniformity of both visual and physical characteristics. Dry ingredients should be mixed before adding the water. The mixture should be pre-hydrated to help prevent shrinkage on drying. To pre-hydrate the mortar, sufficient water is added to the dry mix to make a damp, stiff mortar. After one to two hours the mortar is remixed with additional water to give the desired consistency.

The use of anti-freeze compounds during cold weather is not recommended. Their effectiveness with high lime mortars is questionable. Furthermore, they may contain salts which would be a source of later efflorescence. A better practice is to heat the water and sand, with care taken to prevent scorching of the sand. The masonry then should be protected from freezing.

The use of air entraining agents also is discouraged. These agents are used with concrete to resist frost action and increase plasticity. The air which these agents incorporate into mortar, however, has a detrimental effect on both bond and strength of repointing mortar. Air entraining agents are considered unnecessary in high lime mortars because of their natural plasticity. Air entrainment of 10 to 16 percent, however, may be desirable in areas of extreme exposure where high strength mortars are used.

Use of bonding agents: The use of chemical agents to increase the bond of the new mortar to the old mortar and masonry units should be avoided. These agents generally are unnecessary and can be harmful.

If the joint is properly prepared and moistened prior to placing the new mortar and if the mortar is properly prepared and applied, there will be a good bond between the new mortar and the adjacent surfaces; chemical agents will not significantly improve this bond. If chemical agents are used, there may be a tendency to neglect proper joint preparation in the thought that the agent will make adequate bonding. In actuality, deteriorated mortar or dirt may remain in the joint, and bonding to these materials will not keep the mortar from coming loose. *Chemical agents cannot substitute for adequate joint preparation and proper mortar mixing.* In addition, some of the chemical agent inevitably will become smeared on the exposed face of the masonry and, due to the nature of the material, its removal will be difficult. This situation is especially likely on walls with thin mortar joints.

Filling the joints: Where existing mortar has been removed (or has fallen out) to a depth greater than one inch, these deeper places should be filled first, compacting new mortar in several layers. Once this has been completed, the back of the entire joint may be filled by applying approximately one-fourth inch of mortar and packing the back corners of the joint. This application may extend for several feet. As soon as the applied mortar has reached thumb print hardness, another layer of mortar of approximately the same thickness may be applied. Several layers will be needed to fill the joint flush with the outer surface of the brick. It is important to allow each layer time to lose much of the water and become stiff before the next layer is applied.

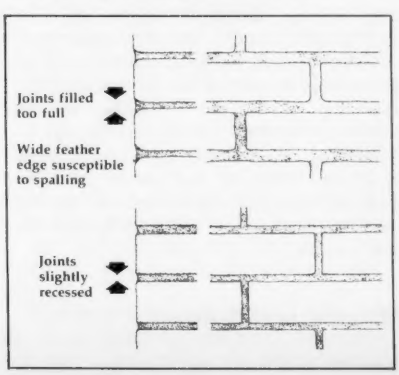
The rate of stiffening can be controlled by dampening the brick and old mortar before beginning to fill the joint. Free water or excessive dampness in the joint must be avoided; too much water will delay the tooling or cause excess shrinkage. If the joint is too dry, water will be absorbed from the mortar before it is properly set, thus reducing bond strength and increasing the probability of leaks.

When the final layer of mortar is thumb print hard, the joint is tooled in a manner to match the appearance of the old mortar. Tooling the finished joint at the right stage of firmness is important for uniform color. If finished while too soft, the color will be lighter than expected and hairline shrinkage cracks are likely to occur. If tooled when too hard, there may be dark streaks called tool burning, and good closure of the mortar against the brick will not be achieved.

If the old bricks have worn, rounded corners, it usually is best to *recess the final mortar surface slightly* to avoid leaving a joint which is visually wider than the actual historical appearance; it also will avoid creation of a large, thin, featheredge which is easily damaged, thus admitting water (Figs. 5 and 6).

Following tooling, it frequently is necessary to remove excess mortar from the

Figure 5. Comparison of visual effect of full mortar joints vs. slightly recessed joints. Filling joints too full hides the actual joint thickness and changes the character of the original brickwork.



edge of the joint by brushing with a bristle brush. The lower portion of the brickwork shown in the photograph on page 15 has been brushed while the middle area has not. (Also see discussion on cleaning below.)

"Aging" the new mortar: Even with the best efforts at matching original mortar color, texture, and materials, there usually will be a visible difference between the old work and the new, partly because the new mortar has been matched to the unweathered portions of the original mortars. Another reason for a slight mismatch may be that the mortar sand may be more exposed in the old mortar due to the slight erosion of the lime or cement. Several methods of treatment have been attempted in an effort to overcome these differences. As with all work, however, any proposed treatment should be carefully considered and tested prior to implementation.

One method of aging the new mortar is a light brushing with a stiff natural brush immediately after tooling. This brushing will roughen the surface slightly, thus producing a weathered look.

Another relatively safe treatment is to fine spray the mortar with low pressure water after completion of tooling. This spray will wash away part of the cement and lime before it is fully hardened, leaving the grains of sand more exposed on the outer surface of the joint as in natural weathering.

Efforts to artificially stain the new mortar may give an initial color match but can cause the new and old mortars to change color at a different rate during the natural aging process. In addition, the mixtures used to stain the mortar may be dangerous to the masonry; some mixtures, for example, can introduce salts into the masonry which then can cause efflorescence. If the mortars have been properly matched, the best treatment for surface color differences is to let the mortars age naturally.

Cleaning: *If repointing work is carefully executed, there will be little excess mortar to clean from the walls.* A conscientious mason will remove most extraneous mortar particles with a bristle brush after the mortar dries but before it hardens. Hardened mortar can be removed with a wooden paddle or, if necessary, a chisel.

Further cleaning is best accomplished with the use of plain water and bristle brushes. If chemicals must be used, the selection must be made with extreme caution to avoid damage to *either the mortar or the masonry*. Selection of an improper cleaner can lead to deterioration of the masonry units or the mortar, mortar smear, and efflorescence. *The use of acid or any agent containing acid should be a last resort*, for acid can destroy the featheredge closure between the finished mortar joint and the brick. Chemical solutions should be used only once and should be flushed freely with plain water to remove all traces of the chemicals.

Several precautions should be taken when cleaning with plain water or with cleaning solutions. The mortar should be fully hardened before cleaning; usually thirty days is sufficient, depending upon weather or exposure. Test cleaning should be conducted on a small section before proceeding with the rest of the building. Both the area to be cleaned and the wall below should be *presoaked with water.* Cleaning the walls of excess mortar should begin at the top and work to the bottom. As the cleaning proceeds, it is important to flush the area with water. Stiff natural brushes should be used for all surfaces except glazed or polished surfaces, for which only soft cloths should be used.

New construction "bloom" or efflorescence occasionally appears within the first few months after repointing and generally disappears through the normal process of weathering. If efflorescence is not removed by natural processes, the safest way to remove it is by dry brushing with bristle brushes followed with a brief water rinse. Chemical cleaners, especially muriatic acid, should be avoided in the removal of efflorescence since the chemicals can create additional salts which may lead to added efflorescence.

Further information on cleaning is contained in Preservation Briefs: No. 1, "The Cleaning and Waterproof Coating of Masonry Buildings," available from the Interagency Historic Architectural Services Program, Office of Archeology and Historic Preservation, National Park Service, Washington, D.C. 20240.

Summary

For the owner: It is important for the owner or administrator of an historic building to be aware that repointing is likely to be a slow and expensive project. Schedules for both the repointing work and other activities will require careful coordination in order to avoid unanticipated conflicts. The work cannot be rushed or overly economized if the building is to retain the proper visual characteristics and if the job is to be durable and watertight.

For the architect/consultant: The architect must assist the owner with planning for the logistical problems relating to research and construction. The architect also must realize that older buildings have special problems not usually encountered in modern construction, so extra research will be required, and other than standard materials and procedures will need to be specified. The qualifications of potential contractors must be carefully evaluated based on previous experience with historic structures, and the contractor must be given special instructions prior to starting the work.

Figure 6. This photograph shows the significant visual changes which can result from improper repointing procedures. Note the increased thickness of the joints, the color variation, and the difference in the method of tooling, all noticeable even from a distance.

For the contractor/craftsman: The requirement for large amounts of slow handwork must be recognized if the contractor is to submit a bid which will reflect these expensive methods. The contractor must explain the special nature of the project to the craftsmen so they will not rush the project. Understanding the potential problems will not only help the contractor in evaluating the project but will also help the masons to understand the reasons that specific methods should or should not be used.

While careful preservation, restoration and maintenance can hold back deterioration, it is important to understand that repointing work probably will not last the life of the structure. Nevertheless, if the first mortar joint has proved durable for many years, careful repointing should also have a long life. Additional repointing jobs can be undertaken as needed without altering structural soundness and original appearance.

Information for this brief was based in part upon:

Rogers, Percy L. "Restoration of Old Masonry," unpublished report for the Office of Archeology and Historic Preservation, National Park Service, Washington, D.C., 1973.

Hartshorne, Penelope. "Repointing of Brick Mortar Joints in Historic Buildings," *Early American Brick Masonry and Restoration of Exterior Brick Walls,* Third Annual Historic Structures Training Conference, National Park Service, Philadelphia, 1963.

Brick Institute of America. "Cleaning Clay Products Masonry," *Technical Notes on Brick Construction*, Number 20 (revised), 1964. [1750 Old Meadowbrook Road, McLean, Virginia, USA]

Additional readings on the subject of repointing are listed below:

Cleaning—Removal of Mortar and Mortar Stains on the Wall Surfaces of New Construction. Chicago: Portland Cement Association, 1963. [Old Orchard Road, Skokie, Illinois, 60076/USA]

Cliver, E. Blaine. "Tests for the Analysis of Mortar Samples," *Bulletin* of the Association for Preservation Technology, Volume VI, Number 1, 1974, pp. 68-73. [Box 2487, Station D, Ottawa, Ontario, K1P 5W6, Canada]

Connor, C.C. and W.E. Okerson. "Recent Disintegration of Mortar in Brick Wall," *ASTM Proceedings, (American Association for Testing and Materials)* Volume 57, 1957.

Kessler, Daniel W. and Ross E. Anderson. *Studies of Stone-Setting Mortar; Building Materials and Structures Report 139.* Washington, D.C.: National Bureau of Standards, U.S. Department of Commerce, 1953.

Loth, Calder. "Notes on the Evolution of Virginia Brickwork from the Seventeenth Century to the Late Nineteenth Century," *Bulletin* of the Association for Preservation Technology, Volume VI, Number 2, 1974, pp. 82-120.

McBurney, John W. "The Effect of Weathering on Certain Mortars Exposed in Brick Masonry With and Without Caps and Flashings," *ASTM Proceedings,* Volume 56, 1956.

McKee, Harley J. *Introduction to Early American Masonry.* Washington, D.C.: National Trust for Historic Preservation/Columbia University, 1973.

National Lime Association, (5010 Wisconsin Ave., N.W., Washington, D.C. 20016 USA) "Tuck Pointing of Masonry Walls," *Limeographs*, Volume 8, Number 9, 1942.

Phillips, Morgan. "SPNEA—APT Conference on Mortar," *Bulletin* of the Association of Preservation Technology, Volume VI, Number 1, 1974, pp. 9-39.

Preservations Brief No. 2 *was developed under the technical editorship of Lee H. Nelson, A.I.A., Technical Preservation Services Division, Office of Archeology and Historic Preservation, National Park Service, U.S. Department of the Interior, Washington, D.C. 20240. April 1976. The line illustrations for this brief were prepared by Robert C. Mack and David W. Look. Photographs by Calder Loth.*

Planting a Tree

Φύτευοι. Α: μπάλλα. Β: μίγμα χώματος

1. Planting: A. ball of roots B. soil mixture.

Λεκάνη ποτίσματος. Τομή σὲ ἐπίπεδο ἔδαφος.

2. Pool for water—on level surface.

Λεκάνη ποτίσματος. Τομή σὲ ἐπικλινὲς ἔδαφος.

3. Pool for water—on a slope.

Σχέδια Μαρίας Βουδούρογλου

Πλάγια στήριξη

4. Support for the newly planted tree.

From Nature and Life, *a quarterly journal published by the Athens Society of Friends of the Trees, Winter 1977.*

Chain Crosspiece for Ladder Safety

Good safety practice demands that when a ladder is in use its siderails, or legs, be firmly positioned on a stable surface, that the steps or crosspieces be level, and that it rest solidly against the wall or other working surface. This latter requirement can be very difficult when attempting to use a ladder against a round pole or tree trunk.

An easy way to increase ladder stability for tree work is to add a crosspiece of chain at the top. The chain will take the form of the tree and grip the bark firmly.

The chain can be affixed in a number of ways but perhaps the simplest is to secure each end through holes in the siderails. These should be no larger than necessary to take the chain. The chain can be kept in place with a bolt (and nut!) fastened through a link in each end. Length of the chain, or play, can be varied to suit by moving one bolt a link or two one way or another.

In a simple variation, a stout manila rope could be substituted for the chain. A figure-of-eight knot is made in each end of the rope on the outer sides of the siderails.

Remember not to lean any ladder too steeply against a work surface. The base should be at least one quarter of its height.

Be certain that any ladder you use is structurally sound, has no broken or missing rungs (crosspieces), or split parts. Never use a ladder where it could come into contact with electrical wires or fixtures.

And never paint a wooden ladder. Paint can conceal cracks or flaws and, in certain circumstances, it may contribute to rot.

When not in use, ladders should be stored horizontally, hung on good solid supports above ground and in a dry place.—R.I. Standish

An Automatic Information Box

Visitor centers, museums, signs, booklets, leaflets and notice boards all have their place in parks, but often these are not enough. There are special situations where nothing is quite as good as the spoken word. This can be presented in various ways, including recorded messages that are available whenever visitors require them at the points of interest.

In 1975 an automatic information box, based on my own design, was constructed for use in the Kennemerduinen National Park. It has the advantage of being virtually invulnerable to vandalism and appears to be very useful.

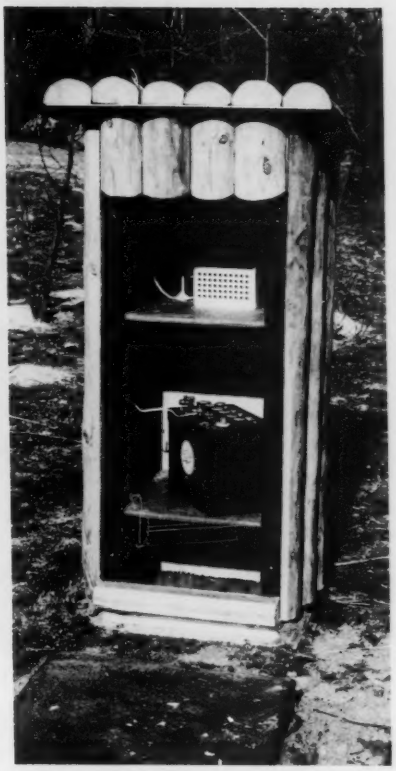
It is a sort of closet made of steel plate and covered with a facing of halved logs. It contains a very simple tape player and a battery to power it. The player uses an endless tape on which is recorded a short lecture on what is to be seen and heard in the vicinity. The lecture lasts approximately six minutes and then repeats. The recorder is activated when someone steps on a footplate in front of the box and it will run as long as the footplate is depressed.

Construction is on a concrete foundation. Bolt-ends are hammered flat to prevent the nuts from being unscrewed.

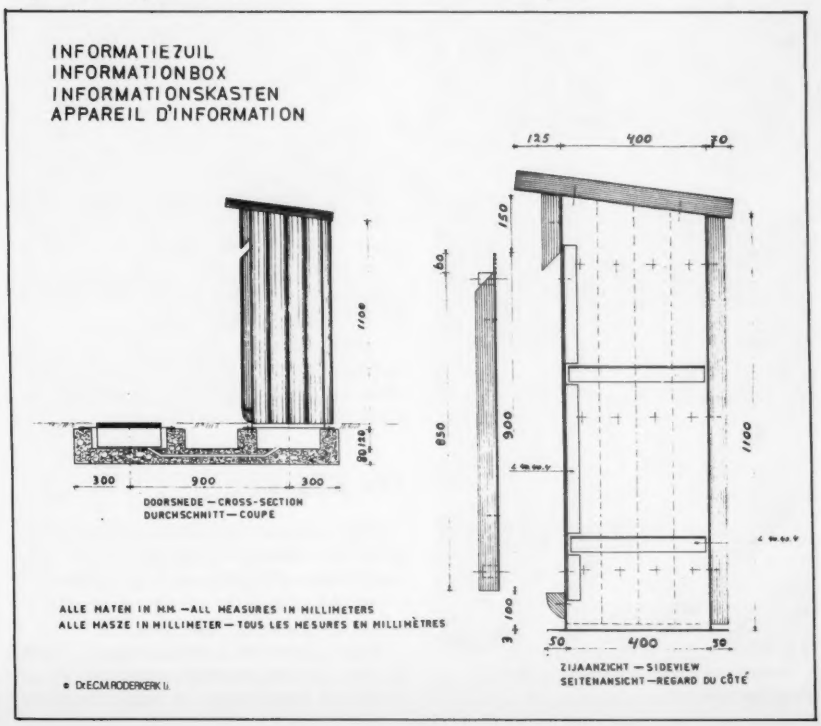
The door is fastened in the closed position by four round-headed bolts. When they are screwed tight, the heads are at the bottom of iron tubes. Unscrewing is possible only with the help of a special key: an iron tube with a cam welded on the inside that fits into a groove in the bolthead. Without that key it is impossible to open the door.

Information Box, ready for "use."

Bolt (one of 4) and special key wrench used to close and open the door.



The Box with door removed to show battery and tape equipment.



The sound aperture at the front is closed by an iron plate with holes in it. The wood facing both above and below the aperture is cut off obliquely, so it is not possible to reach the recorder with a twig or piece of wire poked horizontally through the holes.

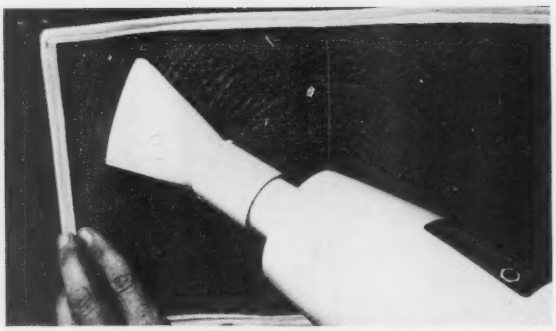
The recorder is enclosed in a plastic bag for protection against dust, sand and moisture.

Springs under the footplate are adjusted so that contact requires a weight of at least 50 kilogrammes (about 110 lbs). Thus the recorder will not go on running if somebody puts a stone or a piece of wood on the footplate.

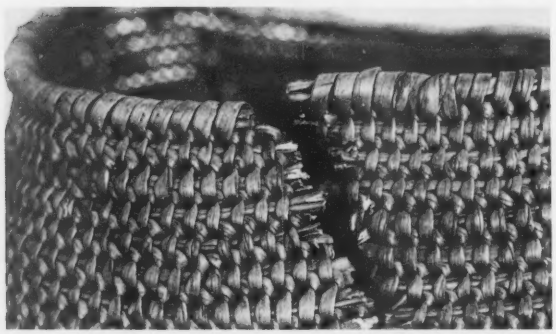
Space between the footplate and the foundation are closed with soft rubber seals to protect the contact plate against moisture. Moreover, the footplate is covered by a hard rubber sheet whose sides are dug into the ground.

This information box can be placed where many visitors pass by or at an overlook or place of special interest. It appeals to the curiosity of the people, and most certainly will be heavily used.—Dr. E.C.M. Roderkerk

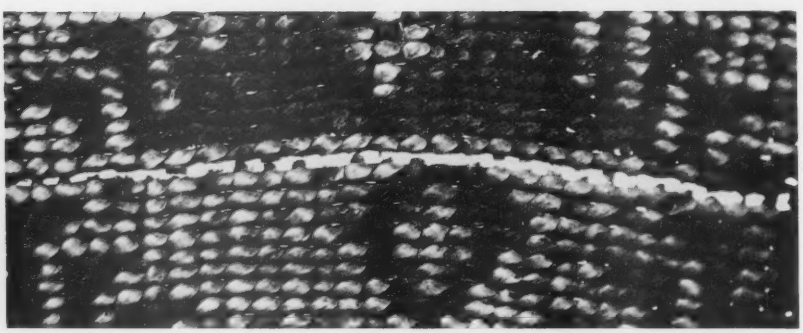
Dr. Roderkerk was Director of the Kennemerduinen National Park until he retired in 1976. He now lives at Pernambucolaan 15, Overeen, The Netherlands.—Ed.



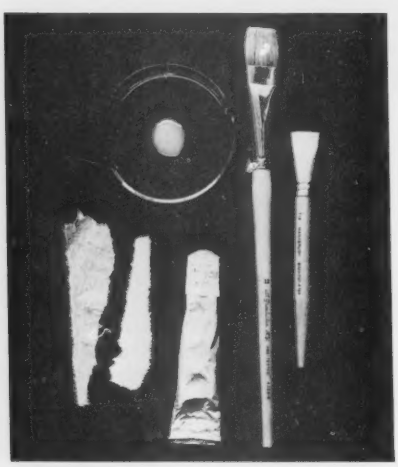
1. Recommended temporary cleaning procedure



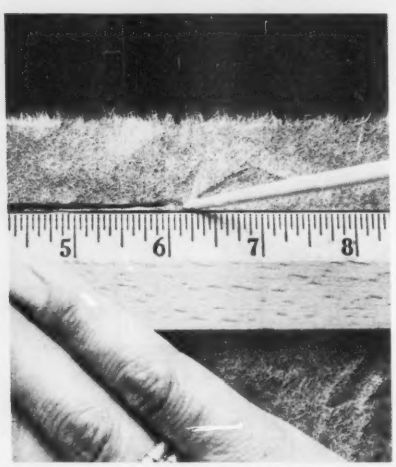
2. Typical damage-break



3. Typical damage-crack



4. Equipment and materials for temporary repair process



5. Scoring of mulberry tissue with wet, blunt instrument

Basket Cleaning and Repair

Park museum collections often contain baskets which are important elements of the cultural heritage of native peoples or other inhabitants of the park area. The following brief guides to their cleaning and first aid mending are taken from the CONSERVE-O-GRAM publications issued by the Division of Museum Services, Harpers Ferry Center, US National Park Service.

Cleaning

Dust on baskets is a serious problem. Dust obscures decoration, destroying the identity of the basket. Dust also acts as a nucleus for attracting moisture droplets which in turn attract moulds, dissolve pollutants, and catalyze decomposition reactions. All of this hastens the deterioration of the basket.

Once dust gets into a basket it is almost impossible to completely remove. Techniques used include:

Brushing with a soft brush—The dust acts as an abrasive. Each time the basket is brushed surface materials are removed. Brushing also increases the danger of knocking off loose pieces.

Blowing with a jet of air—This must be done outside or dust is just moved around. Again, caution must be taken against blowing off loose pieces.

Vacuum cleaning—This is the safest system of cleaning baskets if done properly. A piece of fine plastic mesh is held securely against the basket. The dirt is suctioned off through the mesh. The mesh holds the basket fibers in place and prevents "lifting" them. CAUTION: Do not abrade the basket when moving the mesh.

Wet washing—This technique was often used by native peoples when the baskets were new. This does not mean it is a safe technique for aged fibers. Tests have indicated washing causes long term damage to most aged basket fibers. Washing techniques should be left to the judgement of an experienced conservator.

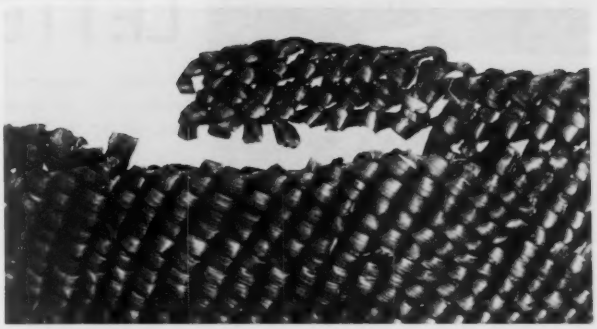
After cleaning, the baskets may be mended if necessary and stored in polyethylene bags that have been perforated to allow for some air circulation.

First aid mending

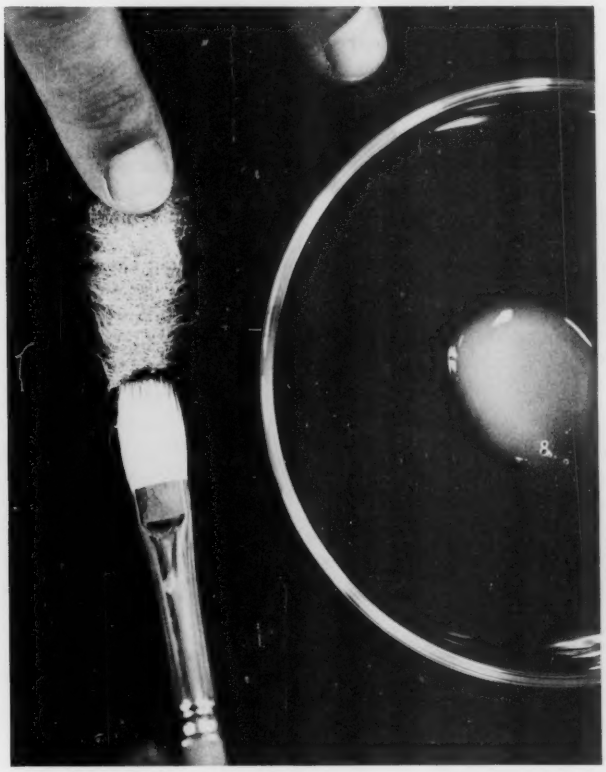
Losing pieces of a basket can make the difference between a simple repair and many hours of tedious work giving mediocre results at best, or may even mean loss of an important exhibit piece.

Loose pieces of a basket can be fixed in place, cracks mended, and weak areas reinforced quite simply. A simple mend to

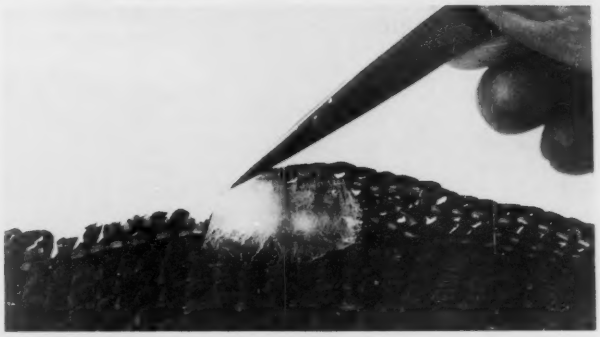
6. Proper tearing action of tissue



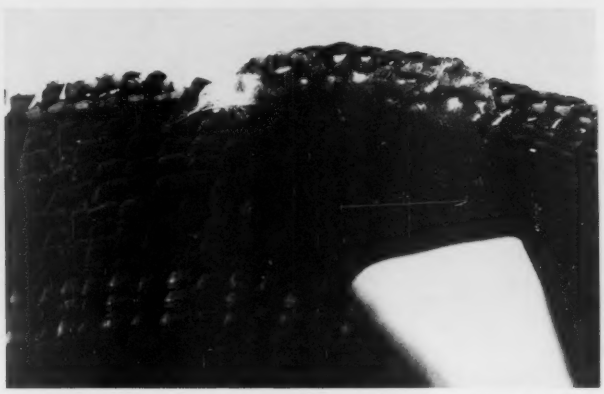
8. Weak area to be mended



7. Application of paste to tissue



9. Application of moist tissue



10. Tapping into place of tissue fibers with soft, dry brush

temporarily stabilize a basket is as follows:

Clean the basket, then assemble the following equipment and materials:

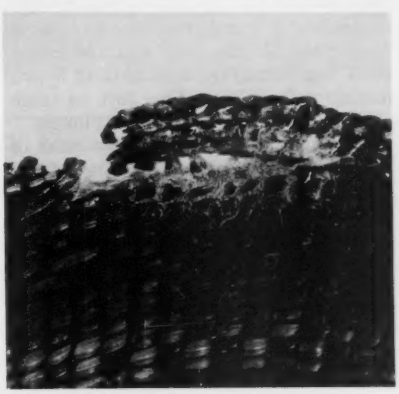
- One soft 1" (2.5 cm) brush
- One stiff 1" (2.5 cm) brush
- Japanese mulberry tissue
- Double boiler
- Blotting paper (optional)
- Starch paste: double boil 15 grams corn starch in ¼ litre water for 45 min.

These supplies are available commercially, from conservation suppliers. Japanese mulberry tissue is a thin, long fiber, hand made tissue.

- Tear the tissue into suitable size strips for the repair as follows: Wet a line down the paper, then pull the paper apart along that line. This type of tear leaves a soft feathered edge.
- Put a strip of tissue on the blotter and spread starch paste over the entire surface. The blotter removes excess water from the paste.
- Place the pasted strip over the damaged area and tap the paper fibers down into the basket fibers with the soft dry brush. Repeat this technique until the damaged area is stabilized.

This repair is not invisible unless done with fine pieces of paper, so mend on the inside of the basket if it is to be exhibited. The repair is meant to be temporary but will hold baskets intact for years. Use only starch paste adhesive—it is reversible. **Do not substitute!**

Fonda G. Thomsen and Toby J. Raphael



11. Finished mend--still damp
Photos: Hali Taylor

Revolving Signs

This "sign" stands next to the langur and macaque enclosures at the Nature Education Center Kahao Chong, in southern Thailand. The question and answer on the exposed faces of the block translates as follows:

Question: *How can you tell which monkeys stay mainly on the ground and which ones stay in the trees?*

Answer: *Look at their tails. The ones with short tails stay mainly on the ground and the long tailed ones stay in the trees.*

This sign and several others like it have proved their worth, and proved again that anything that can be moved or handled attracts visitors' attention.

These blocks can be spun around their axis thereby alternately revealing a question and its answer. All it consists of is a rectangular, wooden block of equal sides (solid or assembled from boards, hardwood for outdoor use), a length of concrete reinforcement steel, and two supports. It is cheap to make and virtually maintenance free, provided the lettering is routed into the wood.

This block is within easy reach of the visitor who looks down on it. Two of its faces are always at least partly exposed to view and it is so unlike any conventional sign that almost everyone feels compelled to touch it . . . and thus discovers that it does move. I may add that the above block was frequently demonstrated by the macaques themselves. They love to reach out from their cage and set it spinning.

Messages are arranged in two pairs of question/answer units. It does happen, of course, that one reads an answer first or in incorrect sequence because the block spins either way. This, however, is not a serious drawback since anyone who is able to read will make sense out of it all the same.—Klaus Berkmüller

LETTERS

PARKS Magazine welcomes thoughtful comments on and criticisms of material appearing in its issues. These comments may represent conflicting interpretations of policy and philosophy. They may provide additional information, and occasionally they will correct errors. Selected letters will be printed here as a service to our readers, and as a forum for constructive dissent. However, we reserve the right to edit and shorten contributions when necessary. Letters should be in English, French or Spanish, be signed with the full name of the writer, and include a complete address for the sender—Ed.

Dear Sir,

While agreeing generally with the article "Management of Red Deer in the Bayerischer Wald National Park" in PARKS, Vol. 2/1/1977, by Mr. Ulrich Wotschikowsky, there are some points on which I disagree:

1) In the Swiss Canton of Graubünden the lack of adjustment of the hunting season is not due to traditional hunting patterns, but to public resistance to killing "park game"—even outside the park.

2) I disagree with the author's definition of "today's Hege". In my opinion *Hege* never did mean to:

- prevent trophy stags from migrating to neighboring hunting grounds. This may have been a silent hope of a trophy hunter as a side effect, but had nothing to do with *Hege*;
- change the natural population structure by selective shooting of age and sex classes. It is intended to reduce the numbers in such a way that the natural population structure is maintained;
- ensure a high level of desired harvest, but to preserve wildlife by keeping their populations at level compatible with the interests of forestry, agriculture and nature conservation. This does not reflect a hunter's rancor, but is what I believe the law considers to be necessary.

"Today's Hege", as defined, is the "preservation of the biosphere for wildlife, including the adaptation of numbers of wildlife to the ecosystem and the adaptation of the environment to the needs of wildlife by consequent management". In my opinion, this kind of management is compatible with national park management, even by excluding any manipulation by man: In this sense it provides for the adaptation of numbers and social structure of deer populations, when necessary, for the benefit of the park's ecosystem. And this is the kind of management which I believe is compatible with the New Delhi principles.

I am perfectly in agreement with Mr. Wotschikowski's suggestions that the red deer which remain during summer in a park which is in higher altitude should, as far as possible, be allowed in winter to wander into the lower levels. I would even go as far as to say that one should try, with the help of winter conditions, to disaccustom the deer from staying in such a park. Many things, of course, have to be done outside the park in order to ensure that undesirable concentrations of deer causing much damage are avoided.

W.E. Burhenne, Bonn.

Dear Sir:

I have just read "Use of Chemical Restraints in Handling Wildlife" by Roy D. Hugie in PARKS, Volume 2, No. 3.

The following points and ideas might have been given greater emphasis or added.

I think the point should have been made that SCC (Succinylcholine Chloride) deteriorates quite rapidly in solution and on heating. The practical implication of this is that fresh solutions should be made up each day and these should be kept out of the sun and away from the engine heat of a vehicle. Also, loaded darts and the dart gun must not get hot if dosages are to maintain their potency.

SCC is a positive killer on some species! (e.g. Zebra) because there is an almost non-existent tolerance band between an underdose and an overdose.

Other systems for firing projectiles that could be mentioned are:

a) Paxarmus Ltd.
P.O. Box 317
Timaru, New Zealand

This system uses blank .22 cartridges as the propellant and has an array of accessories including telescopic sights, etc. The dart velocity, and thus impact, can be adjusted.

b) Tele-Narco-Technik
c/o Behr Chemie
73 Brack
2 Hamburg, West Germany

This system uses a modified 12 gauge shotgun with special optical sights and sound suppressors.

Two further practical hints are:

a) Blindfold animals that are immobilized with substances that leave them fully conscious (such as SCC) to reduce the traumatic effects of being approached and handled.
b) Wherever possible, a wildlife veterinarian should be involved in the immobilisation. *This is a must when dealing with rare or endangered species.*

Finally, one important reference that Mr. Hugie appears to have overlooked is the book "The Capture and Care of Wild Animals"—Editor Dr. E. Young, published by Human and Rousseau, Pretoria, 1973.

G.S. Child, FAO/ROME

Migrating dunes, Doñana National Park, Spain, (1977). Photo: Rollin D. Sparrowe.

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